Lucent Technologies
Bell Labs Innovations

DDM-2000 OC-3 and OC-12 Multiplexers

Applications, Planning, and Ordering Guide

363-206-200 R15
Issue 10
April 2002

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***DDM-2000 OC-3 and OC12 Multiplexers Applications, Planning, and Ordering Guide*, Release 15 (OC-3) and Release 7 (OC-12)**

363-206-200 Issue 10 Date: April 2002

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A A SONET Overview

About This Document

Purpose

This applications, planning, and ordering guide provides specific information about the features, applications, operation, engineering, and ordering of the DDM-2000 OC-3 and OC-12 Multiplexers. The following sections cover feature highlights and network applications, plus product information on transmission and control. The system-level operations philosophy and features are described in the section on operations, administration, maintenance, and provisioning (OAM&P). Other sections provide guidelines for system planning and ordering, and summarize Lucent Technologies' extensive product support program.

Intended Audiences

This applications, planning, and ordering guide is primarily for network planners, engineers, and sales teams. It may be used by anyone desiring specific information about the features, applications, operation, engineering, and ordering of the DDM-2000 OC-3 and OC-12 Multiplexers.

Reason for Reissue

This document, Issue 10, replaces the *DDM-2000 Multiplexer Applications, Planning, and Ordering Guide*, Issue 9.

Major changes include:

- Removal of the 29G2-U OLIU
- Include references to WaveStar TDM 2.5G and 10G
- Update cable drawings and software tables
- Update circuit pack information including availability

NOTE:
This APOG covers software releases up to and including TARP releases R15.0 (OC-3) and R7.0 (OC-12). The impact of introducing TARP will affect many areas of this document. Be aware that both TARP and the Lucent Directory Services (LDS) protocol operations are discussed, and that some operations and features available in pre-TARP releases will no longer be applicable in Releases 15.0/7.0.

Operations Interworking using TARP

Release 15.0 of the DDM-2000 OC-3 Multiplexer and Release 7.0 of the DDM-2000 OC-12 Multiplexer use Telcordia Technologies' GR-253 Target ID Address Resolution Protocol (TARP). The Operations Interworking function provided by TARP offers an alternative to the Lucent Directory Services protocol (LDS)* but will impact operations in a number of ways. The following synopsis highlights TARP and its impact on network operations:

Why — Lucent Technologies offers TARP for Operations Interworking as a standard protocol recommended by Telcordia Technologies for TL1 OS applications to support interworking with other vendors' equipment (TARP is supported by multiple vendors).

When — DDM-2000 OC-3 Releases 15.0 and 13.0 and DDM-2000 OC-12 Release 7.0 use TARP for OI use (transmission through non-TARP NEs will not be affected). DDM-2000 FiberReach R4.0, FT-2000 R9.1, and *SLC*-2000 R4.7 are also TARP compatible.

Impact — The following items list some of the areas impacted by the implementation of TARP. For more detailed information, refer to the *DDM-2000 OC-3 Release 15.0 Software Release Description*, 363-206-231, Issue 1, and the *DDM-2000 OC-12 Release 7.0 Software Release Description*, 363-206-255, Issue 1.

- Remote alarms are not reported via the DCC using the AGNE and Alarm Group concept in TARP OC-3 Release 13.x and OC-12 Release 7.x. TL1/X.25 OS systems will also retrieve remote network alarm information.
- Remote alarms will be reported via the DCC using the AGNE and Alarm Group concept in TARP Release 15.0. TL1/X.25 OS systems will also retrieve remote network alarm information.
- There will no longer be a DSNE, TBOS, Site, and NE information. TARP data cache will be maintained by each individual NE for its connectivity.
- CPro-2000 Release 11.1 and ITM SNC Release 10.0 will support DDM-2000 OC-3/OC-12 Releases 15.0/7.0.
- Releases 15.0/7.0 still support Lucent proprietary applications such as remote Craft Interface Terminal (CIT) login, remote software download, and remote NE-to-NE automatic time/date synchronization at start-up.

Subnetworks of up to 256 NEs will be supported using subnetwork partitioning into multiple Level 1 areas.

* Release 11.1 and any future non-TARP releases will continue to support LDS.

Related Documentation

The following documents provide additional information about the DDM-2000 Multiplexers:

- Number: 190-523-101 (User Manual only) Release 3.0
  Order Comcode 107265944 for User Manual & Software for Release 3.0

  Title: *CPro-2000 User Manual*

  Audience: Maintenance personnel

  Content: Using the tool to provision and maintain ring networks

- Number: 365-576-100 (User Manual only) Release 4.0
  Number: 365-576-101 (User Manual & Software) Release 4.0

  Title: *CPro-2000 User Manual*

  Audience: Maintenance personnel

  Content: Using the tool to provision and maintain ring networks

- Number: 365-576-110 (User Manual only) Release 5.0
  Number: 365-576-111 (User Manual & Software) Release 5.0

  Title: *CPro-2000 User Manual*

  Audience: Maintenance personnel

  Content: Using the tool to provision and maintain ring networks

- Number: 365-576-120 (User Manual only) Release 6.0
  Number: 365-576-121 (User Manual & Software) Release 6.0

  Title: *CPro-2000 User Manual*

  Audience: Maintenance personnel

  Content: Using the tool to provision and maintain ring networks

- Number: 365-576-125 (User Manual only) Release 6.1
  Number: 365-576-126 (User Manual & Software) Release 6.1

  Title: *CPro-2000 User Manual*

  Audience: Maintenance personnel

  Content: Using the tool to provision and maintain ring networks

- Number: 365-576-130 (User Manual only) Release 7.0
  Number: 365-576-131 (User Manual & Software) Release 7.0

  Title: *CPro-2000 User Manual*

  Audience: Maintenance personnel

  Content: Using the tool to provision and maintain ring networks

- Number: 365-576-140 (User Manual only) Release 8.0
  Number: 365-576-141 (User Manual & Software) Release 8.0

  Title: *CPro-2000 User Manual*

  Audience: Maintenance personnel

  Content: Using the tool to provision and maintain ring networks

- Number: 365-576-150 (User Manual only) Release 9.0
  Number: 365-576-151 (User Manual & Software) Release 9.0

  Title: *CPro-2000 User Manual*

  Audience: Maintenance personnel

  Content: Using the tool to provision and maintain ring networks

- Number: 365-576-160 (User Manual only) Release 10.0
  Number: 365-576-161 (User Manual & Software) Release 10.0

  Title: *CPro-2000 User Manual*

  Audience: Maintenance personnel

  Content: Using the tool to provision and maintain ring networks

- Number: 365-576-170 (User Manual only) Release 11.1
  Number: 365-576-171 (User Manual & Software) Release 11.1

  Title: *CPro-2000 User Manual*

  Audience: Maintenance personnel

  Content: Using the tool to provision and maintain ring networks

- Number: 363-206-201

  Title: *DDM-2000 OC-3 Multiplexer, System Commands Quick Reference*

  Audience: Maintenance personnel

  Content: Abbreviated list of system commands and parameters for DDM-2000 OC-3 Multiplexers through Release 7.2

- Number: 363-206-202

  Title: *DDM-2000 OC-3 Multiplexer User/Service Manual, Volumes I and II*

  Audience: Maintenance personnel

  Content: Detailed description, technical specifications, commands and reports (Volume I), and operations and maintenance procedures (Volume II) for DDM-2000 OC-3 Multiplexers through Release 7.2

- Number: 363-206-204

  Title: *DDM-2000 OC-3 Multiplexer Installation Manual*

  Audience: Customers planning to install the equipment

  Content: Customer installation instructions

- Number: 363-206-206

  Title: *DDM-2000 OC-12 Multiplexer — System Commands Quick Reference*

  Audience: Maintenance personnel

  Content: Abbreviated list of system commands and parameters for DDM-2000 OC-12 Multiplexers through Release 3.1

- Number: 107-564-270

  Title: *ITM SNC Users Guide*

  Audience: Operations Personnel

  Content: Integrated Transport Management Subnetwork Controller information (Release 6.0 and earlier)

- Number: 190-223-100

  Title: *ITM SNC Users Guide*

  Audience: Operations Personnel

  Content: Integrated Transport Management Subnetwork Controller information (Release 8.0 and later)

- Number — 107-564-288

  Title — *Integrated Transport Management SubNetwork Controller (ITM SNC) System Administration Guide*

  Audience — Administration Personnel

  Content — Integrated Transport Management Subnetwork Controller information

- Number: 363-206-207

  Title: *DDM-2000 OC-12 Multiplexer and OC-12 Regenerator User/Service Manual*

  Audience: Maintenance personnel

  Content: Detailed description, technical specifications, commands and reports, and operations and maintenance procedures for DDM-2000 OC-12 Multiplexers through Release 3.1 and OC-12 Regenerator through Release 2.0

- Number: 363-206-208

  Title: *DDM-2000 OC-12 Multiplexer Installation Manual*

  Audience: Customers planning to install the equipment

  Content: Customer installation instructions

- Number: 363-206-220

  Title: *DDM-2000 OC-3/OC-12 Multiplexer Circuit Pack Options Job Aid*

  Audience: Maintenance personnel

  Content: List of circuit pack options

- Number: 363-206-222

  Title: *DDM-2000 OC-3/OC-12 Multiplexer Acceptance Task List Job Aid*

  Audience: Maintenance personnel

  Content: Checklist of acceptance and turnup procedures

- Number: 363-206-223

  Title: *DDM-2000 OC-12 Regenerator — System Commands Quick Reference*

  Audience: Maintenance personnel

  Content: Abbreviated list of system commands and parameters

- Number: 363-206-280

  Title: *DDM-2000 OC-3 Multiplexer User/Service Manual, Volumes I and II*

  Audience: Maintenance personnel

  Content: Detailed description, technical specifications, commands and reports (Volume I), and operations and maintenance procedures (Volume II) for DDM-2000 OC-3 Multiplexer Releases 8.1, 9.1, 11.0, and 11.1

- Number: 363-206-281

  Title: *DDM-2000 OC-3 Multiplexers — System Commands Quick Reference*

  Audience: Maintenance personnel

  Content: Abbreviated list of system commands and parameters for DDM-2000 OC-3 Multiplexer Releases 8.1, 9.1, 11.0, and 11.1

- Number: 363-206-285

  Title: *DDM-2000 OC-3 Multiplexer User/Service Manual, Volumes I and II*

  Audience: Maintenance personnel

  Content: Detailed description, technical specifications, commands and reports (Volume I), and operations and maintenance procedures (Volume II) for DDM-2000 OC-3 Multiplexer Release15.0

- Number: 363-206-286

  Title: *DDM-2000 OC-3 Multiplexers — System Commands Quick Reference*

  Audience: Maintenance personnel

  Content: Abbreviated list of system commands and parameters for DDM-2000 OC-3 Multiplexer Release 13.0

- Number: 363-206-290

  Title: *DDM-2000 OC-12 Multiplexer User/Service Manual, Volumes I and II*

  Audience: Maintenance personnel

  Content: Detailed description, technical specifications, commands and reports (Volume I), and operations and maintenance procedures (Volume II) for DDM-2000 OC-12 Multiplexer Release 5.1

- Number: 363-206-291

  Title: *DDM-2000 OC-12 Multiplexers — System Commands Quick Reference*

  Audience: Maintenance personnel

  Content: Abbreviated list of system commands and parameters for DDM-2000 OC-12 Multiplexer Release 5.1

- Number: 363-206-295

  Title: *DDM-2000 OC-12 Multiplexer User/Service Manual, Volumes I and II*

  Audience: Maintenance personnel

  Content: Detailed description, technical specifications, commands and reports (Volume I), and operations and maintenance procedures (Volume II) for DDM-2000 OC-12 Multiplexer Release 7.0

- Number: 363-206-296

  Title: *DDM-2000 OC-12 Multiplexers — System Commands Quick Reference*

  Audience: Maintenance personnel

  Content: Abbreviated list of system commands and parameters for DDM-2000 OC-12 Multiplexer Release 7.0

- Number: 363-206-300

  Title: *DDM-2000 FiberReach Applications, Planning, and Ordering Guide*

  Audience: Network planners, equipment engineers, and sales teams

  Content: Features; applications; high-level description; operations, administration, maintenance, and provisioning (OAM&P); system planning; ordering; product support; reliability information; technical specifications; and a synchronous optical network (SONET) overview

- Number: 363-206-301

  Title: *DDM-2000 FiberReach User/Service Manual*

  Audience: Maintenance personnel

  Content: Detailed description, technical specifications, and O&M procedures for the DDM-2000 FiberReach Multiplexer Wideband Shelf, Release 2.1 and 2.2

- Number: 363-206-305

  Title: *DDM-2000 FiberReach User/Service Manual*

  Audience: Maintenance personnel

  Content: Detailed description, technical specifications, and O&M procedures for the DDM-2000 FiberReach Multiplexer Wideband Shelf, Release 3.1 and 4.0.

- Number: 363-206-310

  Title: *DDM-2000 FiberReach Installation Manual*

  Audience: Users planning to install the equipment

  Content: Customer installation instructions

- Number: 824-102-144

  Title: *Lucent Technologies 2000 Product Family, Operations Interworking Guide For TARP Releases*

  Audience: Maintenance personnel

  Content: Operations interworking information for the Lucent Technologies Product Family 2000 systems, including DDM-2000 Multiplexers and FT-2000 OC-48 Lightwave System

- Number: 824-102-147

  Title: *Lucent Technologies 2000 Product Family Operations Interworking Guide*

  Audience: Maintenance personnel

  Content: Operations interworking information for the Lucent Technologies Product Family 2000 systems, including DDM-2000 Multiplexers and FT-2000 OC-48 Lightwave System

- Number: 824-102-148

  Title: *FT-2000 Operations Systems Engineering Guide*

  Audience: Engineers

  Content: Operations systems engineering information for the FT-2000 OC-48 Lightwave System

- Number: 824-102-149

  Title: *SLC ®-2000 Access System Operations Systems Engineering Guide*

  Audience: Engineers

  Content: Operations systems engineering information for *SLC*-2000

- Number: 824-102-151

  Title: *DDM-2000 Multiplexers Operations Systems Engineering Guide*

  Audience: Engineers

  Content: Operations systems engineering information for the DDM-2000 OC-3, OC-12, and FiberReach Multiplexers

- Number: 365-372-300

  Title: *Metropolis® DMX Access Multiplexer Applications and Planning Guide*

  Audience: Network planners, analysts, and managers

  Content: Features, applications, operation, engineering, support, specifications, and ordering.

- Number: 365-372-301

  Title: *Metropolis® DMX Access Multiplexer User Operations Guide*

  Audience: Technicians in the field of telecommunications and communications network providers; procedural material is written primarily for maintenance, operation, and provisioning personnel responsible for the operation and maintenance of the Metropolis® DMX.

  Content: Detailed descriptive information to the circuit pack level; acceptance, operation, and provisioning tasks.

- Number: 365-372-302

  Title: *Metropolis® DMX Alarm Messages and Trouble Clearing Guide*

  Audience: Technicians in the field of telecommunications and communications network providers; procedural material (tasks) is written primarily for maintenance, operation, and provisioning personnel responsible for the operation and maintenance of the Metropolis® DMX.

  Content: Maintenance and trouble clearing information and tasks; a central directory of alarm messages.

- DDM-2000 OC-3 Drawings:

ED-8C724-10	OC-3 and OC-3/OC-12 Combined Bay Arrangements
ED-8C724-15	Cabling Plan (Rear Access)
ED-8C724-16	Cabling Plan (Front Access)
ED-8C724-20	Cable Assemblies
ED-8C724-21	Cable Assemblies
ED-8C724-22	Cable Assemblies
ED-8C724-30	DDM-2000 Shelf Assembly
ED-8C724-31	User Panel Assembly
ED-8C724-34	Releases 2 and 3 Software Ordering
ED-8C724-36	Release 5 Software Ordering
ED-8C724-37	Release 6 Software Ordering
ED-8C724-38	Release 7 Software Ordering
ED-8C724-39	Release 8 Software Ordering
ED-8C724-40	Release 9 Software Ordering
ED-8C724-41	Release 11 Software Ordering
ED-8C724-42	Release 13 Software Ordering
ED-8C724-43	Release 15 Software Ordering
ED-8C733-30	Fan, Filter, and Baffle Assemblies
SD-7C510-01	Application Schematic
T7C510-31	Interconnect Wiring (Rear Access)
T7C510-32	Interconnect Wiring (Front Access)
801-525-168	Floor Plan Data Sheets

- DDM-2000 OC-12 Drawings:

ED-8C724-10	OC-3 and OC-3/OC-12 Combined Bay Arrangements
ED-8C727-10	Typical Bay Arrangements
ED-8C727-15	Cabling Plan (Rear Access)
ED-8C727-16	Cabling Plan (Front Access)
ED-8C727-20	Cable Assemblies
ED-8C727-21	Cable Assemblies
ED-8C727-30	Shelf Assembly
ED-8C727-31	User Panel Assembly
ED-8C727-34	DDM-2000 OC-12 Release 2 Software Ordering
ED-8C727-35	DDM-2000 OC-12 Release 3 Software Ordering
ED-8C727-36	DDM-2000 OC-12 Release 5 Software Ordering
ED-8C727-37	DDM-2000 OC-12 Release 7 Software Ordering
ED-8C727-41	DDM-2000 OC-12 Regenerator Release 2 Software Ordering
SD-7C513-01	Application Schematic
T7C513-31	Interconnect Wiring Diagram (Rear Access)
T7C513-32	Interconnect Wiring (Front Access)
801-525-168	Floor Plan Data Sheets

DDM-2000 equipment is also available in traditional loop enclosure arrangements, descriptions of which may be found in the following Lucent Technologies Practices:

- Number: 363-205-000

  Title: *SLC Series 5 Carrier System Ordering Guide — Loop Transmission Systems* (to be replaced by 363-205-010)

- Number: 363-205-010

  Title: *SLC Series 5 System Applications and Planning Guide*

- Number: 626-500-105

  Title: *80-type Cabinets Ordering Information and Lettering Guide*

- Number: 626-500-115

  Title: *90-type Cabinets Coding and Ordering Information*

The following documents provide additional information about WaveStar BandWidth Manager:

- Number — 365-370-100

  Title — *WaveStar BandWidth Manager Installation Manual*

  Content — Provides a step-by-step guide to system installation and setup. It also includes information needed for preinstallation site planning and postinstallation acceptance testing.

- Number — 365-370-101

  Title — *WaveStar BandWidth Manager Applications, Planning, and Ordering Guide*

  Content — Presents a high-level overview of the system, describes its applications, gives planning requirements, engineering rules, ordering information, and technical specifications.

- Number — 365-370-102

  Title — *WaveStar BandWidth Manager User/Service Manual*

  Content — Provides a detailed description of the product step-by-step information for use in daily system operations. The manual demonstrates how to perform system provisioning, operations, and administrative tasks. It also provides procedures for routine maintenance, troubleshooting, diagnostics, and component replacement.

- Number — 365-370-103

  Title — *WaveStar BandWidth Manager Provisionable Parameters Job Aid*

  Content — Provides unit numbering diagrams, system mappings, equipment module diagrams and tables, system test procedures, and performance monitoring procedures.

- Number — 365-370-104

  Title — *WaveStar BandWidth Manager Operations Systems Engineering Guide*

  Content — Provides detailed information on TL1 commands, messages, and error codes.

The following documents provide additional information about WaveStar TDM 2.5G:

- Number — 365-371-101

  Title — *WaveStar TDM 2.5G Applications, Planning, and Ordering Guide*

  Content — Presents a high-level overview of the system, describes its applications, gives planning requirements, engineering rules, ordering information, and technical specifications.

- Number — 365-371-102

  Title — *WaveStar TDM 2.5G User/Service Manual*

  Content — Provides a detailed description of the product step-by-step information for use in daily system operations. The manual demonstrates how to perform system provisioning, operations, and administrative tasks. It also provides procedures for routine maintenance, troubleshooting, diagnostics, and component replacement.

- Number — 365-371-103

  Title — *WaveStar TDM 2.5G Provisionable Parameters Job Aid*

  Content — Provides unit numbering diagrams, system mappings, equipment module diagrams and tables, system test procedures, and performance monitoring procedures.

- Number — 365-371-104

  Title — *WaveStar TDM 2.5G Cross-Connection Job Aid*

  Content — Provides unit numbering diagrams, system mappings, equipment module diagrams and tables, system test procedures, and performance monitoring procedures.

- Number — 365-371-106

  Title — *WaveStar TDM 2.5G Installation Manual*

  Content — Provides a a step-by-step guide to system installation and setup. It also includes information needed for preinstallation site planning and postinstallation acceptance testing.

- Number — 365-371-107

  Title — *WaveStar TDM 2.5G Operations Systems Engineering Guide*

  Content — Provides detailed information on TL1 commands, messages, and error codes.

The following documents provide additional information about WaveStar TDM 10G:

- Number — 365-371-301

  Title — *WaveStar TDM 10G Applications, Planning, and Ordering Guide*

  Content — Presents a high-level overview of the system, describes its applications, gives planning requirements, engineering rules, ordering information, and technical specifications.

- Number — 365-371-302

  Title — *WaveStar TDM 10G User/Service Manual*

  Content — Provides a detailed description of the product step-by-step information for use in daily system operations. The manual demonstrates how to perform system provisioning, operations, and administrative tasks. It also provides procedures for routine maintenance, troubleshooting, diagnostics, and component replacement.

- Number — 365-371-303

  Title — *WaveStar TDM 10G Provisionable Parameters Job Aid*

  Content — Provides unit numbering diagrams, system mappings, equipment module diagrams and tables, system test procedures, and performance monitoring procedures.

- Number — 365-371-304

  Title — *WaveStar TDM 10G Cross-Connection Job Aid*

  Content — Provides unit numbering diagrams, system mappings, equipment module diagrams and tables, system test procedures, and performance monitoring procedures.

- Number — 365-371-306

  Title — *WaveStar TDM 10G Installation Manual*

  Content — Provides a a step-by-step guide to system installation and setup. It also includes information needed for preinstallation site planning and postinstallation acceptance testing.

- Number — 365-371-307

  Title — *WaveStar TDM 10G Operations Systems Engineering Guide*

  Content — Provides detailed information on TL1 commands, messages, and error codes.

The following documents provide additional information about related equipment:

- Number: 363-206-150

  Title: *DDM-Plus User/Service Manual*
- Number: 363-206-151

  Title: *DDM-Plus Installation Manual*
- Number: 363-206-152

  Title: *DDM-Plus Quick Reference Guide*
- Number: 363-206-156

  Title: *DDM-Plus Equipment Engineering and Ordering Guide*
- Number: 363-206-157

  Title: *DDM-Plus Wall DT Installation Manual*
- Number: 365-303-102

  Title: *DSX-3 Cross-Connect Bay, Description, Operation, and Maintenance Manual*
- Number: 365-301-130

  Title: *System III DSX-3/4, Planning, Engineering, Installation, and Operation — System Reference Guide*
- Number: 365-331-000

  Title: *DACS III-2000 Release 2.0 Applications, Planning, and Ordering Guide*
- Number: 365-340-800

  Title: *DACS IV-2000 Release 5.0 Reference Manual*
- Number: 365-575-100

  Title: *FT-2000 OC-48 Lightwave System Applications, Planning, and Ordering Guide*
- Number: 636-299-120

  Title: *LGX® Distribution System, Planning, Engineering, Installation, and Operation System Reference Guide*

- Title: MegaStar ™ 2000 Documents

Comcode 107585648	Installation Manual
Comcode 407397512	Schematic Package
Comcode 107585655	Reference Manual
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Introduction

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Overview

This section introduces the Lucent 2000 Product Family and briefly describes the DDM-2000 OC-3 Multiplexer and the DDM-2000 OC-12 Multiplexer.

Lucent 2000 Product Family

Lucent Technologies is focused on a carefully planned and growing product family designed to provide total network solutions. The 2000 Product Family complies with the synchronous optical network (SONET) standard and builds on features and capabilities that customers have found to be useful and successful in networks such as single-ended maintenance features and product upgrade capabilities. These upgrade capabilities allow a graceful evolution from today's asynchronous networks to the world-class intelligent networks of the future. The 2000 Product Family provides the significant elements of the Lucent Technologies Service Net-2000 Architecture.

Lucent's Service Net-2000 Architecture starts with the network as it exists today and provides real-world solutions to build upon your existing base. It also allows a graceful evolution from rigid wire centers to a network of flexible nodes. This network distributes intelligence to where it functions best.

The Service Net-2000 Architecture offers access bandwidth, service on demand, and self-healing network applications. Access bandwidth offers increased capacity, giving end users the ability to access any desired service. This increased access bandwidth, provided over fiber, offers superior network reliability while opening up new revenue opportunities.

Service on demand offers high-capacity services implemented in short intervals. This application gives local exchange carriers the opportunity to generate new revenue faster by provisioning new services at a competitive "fast start" pace. At the same time, they help maintain the existing revenue base by increasing

customer satisfaction. Service on demand also reduces start-up costs, thereby improving capital management.

The self-healing network application involves careful planning and provisioning of cross-product capabilities with the 2000 Product Family. At the core of this network is DACS III-2000 and DACS IV-2000 Cross-Connect Systems, the nerve center of interoffice transmission. The intelligent DACS III-2000 and DACS IV-2000 Cross-Connect Systems, working with the *DACScan*®-2000 Controller, can identify failed connections and reroute signals according to a preestablished recovery plan.

The Lucent 2000 Product Family includes the:

- DDM-2000 OC-3 Multiplexer
- DDM-2000 OC-12 Multiplexer
- DDM-2000 FiberReach Multiplexer
- FT-2000 OC-48 Lightwave System
- DACS III-2000 Cross-Connect System
- DACS IV-2000 Cross-Connect System
- *DACScan*-2000 Controller
- *SLC*®-2000 Access System
- Business Remote Terminal-2000 (BRT-2000)
- ITM SNC Sub-Network Controller

DDM-2000 Product Family

The DDM-2000 Product Family includes the DDM-2000 OC-3 Multiplexer, the DDM-2000 OC-12 Multiplexer, the DDM-2000 FiberReach Multiplexer, and DDM-Plus. The DDM-2000 OC-3 and OC-12 Multiplexers are designed for loop (access), interoffice (transport), and customer location applications. They start with many of the proven features of Lucent's DDM-1000 Multiplexer and extend into the future with the flexibility of the SONET standard. The DDM-2000 OC-3 Multiplexer operates at 155 Mb/s or 622 Mb/s, and the DDM-2000 OC-12 Multiplexer operates at 622 Mb/s. Both multiplexers provide flexible and evolvable network solutions. With common operations practices and circuit pack reuse, your investment (for example, technician training, circuit pack inventory) is preserved as the network evolves to higher capacities and advanced topologies.

The DDM-Plus provides a cost-effective fiber extension from the DDM-1000 or DDM-2000 OC-3 and OC-12 Multiplexers transporting one to four DS1s on a fiber pair, either in a 1x1 protected or unprotected configuration.

The DDM-2000 FiberReach Multiplexer is the newest member of the DDM-2000 product family. The DDM-2000 FiberReach Multiplexer is a full-service access product, combining a 48-line optical network unit with a complete DS1 interface product. DDM-2000 FiberReach is a SONET product that is "hosted" by either a DDM-2000 OC-3 Multiplexer or a *SLC*-2000 Access System. The extension from the host node is an OC-1 signal in a ring topology. The DDM-2000 FiberReach Multiplexer operates at 51.84 Mb/s. The DDM-2000 FiberReach Multiplexer can be used in DDM-Plus applications where increased capacity and interworking features are needed. FiberReach can also be equipped with OC-3 or OC-12 optics and used as a node on a ring with other DDM-2000 OC-3 or OC-12 shelves. See 363-206-300, *DDM-2000 FiberReach Applications, Planning, and Ordering Guide*, for more information.

The DDM-2000 OC-3 Multiplexer supports many network topologies such as point-to-point, OC-3 fiber hubbing, and linear and ring DS1/DS3/EC-1 add/drop and OC-1 rings with time slot interchange (TSI) in a single 8.5 inch high shelf. The DDM-2000 OC-3 shelf, in addition, now offers ring capacity upgrade to OC-12 for higher bandwidth applications. This is achieved by replacing the OC-3 optics with OC-12 optics in the same DDM-2000 OC-3 shelf. Each topology is supported with efficiency and a full complement of operations features.

The DDM-2000 OC-12 Multiplexer supports several stand alone topologies including point-to-point, hubbing, and ring configurations. In addition, the DDM-2000 OC-12 multiplexer is an efficient OC-12 upgrade to all the OC-3 network configurations. Installed together, the DDM-2000 OC-3 and OC-12 Multiplexers provide integrated DS1 to OC-12 multiplexing.

The DDM-2000 OC-12 Multiplexer also supports regenerator applications in balanced and unbalanced modes.

The DDM-2000 Multiplexers are designed for easy installation and operation. Centralized operations are supported by a full set of single-ended control and maintenance features. Integrated test capabilities and default provisioning simplify installation. Most tasks can be performed using faceplate LEDs, displays and controls, while a craft interface terminal (CIT) gives access to sophisticated provisioning, maintenance and reporting features. A personal computer (PC) is needed to download software and to run CPro-2000 graphical user interface tool software.

In this document, the term "DDM-2000 Multiplexer" is used to reflect the DDM-2000 OC-3, DDM-2000 OC-12, and DDM-2000 FiberReach Multiplexers. Since many features, functions, and circuit packs are common among these multiplexers, information generic to all multiplexers is presented with the DDM-2000 Multiplexer designation. Information specific to a multiplexer is described with the DDM-2000 OC-3, DDM-2000 OC-12, or DDM-2000 FiberReach designation, as appropriate.

Introduction to the DDM-2000 OC-3 Multiplexer

The DDM-2000 OC-3 Multiplexer is a single shelf SONET digital multiplexer. It is capable of multiplexing up to 84 DS1 signals, or 3 DS3 signals, or 3 EC-1 signals or 6 OC-1 signals, or a combination of DS1, EC-1, and DS3, and OC-1 signals, into a SONET standard 155.52 Mb/s optical carrier level 3 (OC-3) signal or a 622-Mb/s OC-12 signal. The OC-3/OC-12 line, all transmission-affecting circuit packs, and the –48 V DC power feeders may be optionally protected. The shelf can be equipped to serve many diverse network applications and supports a variety of operations interfaces for current and evolving network operations needs.

The DDM-2000 OC-3 Multiplexer is designed for loop (access), interoffice (transport), and customer location applications. The DDM-2000 OC-3 Multiplexer starts with many of the proven features of Lucent's DDM-1000 multiplexer and extends into the future with the flexibility of the SONET standard.

A single 8.5-inch high shelf supports a mix of digital signal 1 (DS1), digital signal 3 (DS3), optical carrier level 1 (OC-1), optical carrier level 3 (OC-3), electrical carrier signal level 1 (EC-1), OC-3c (STS-3c), and IS-3 signal interfaces satisfying a wide range of lightwave terminal and SONET electrical multiplexer applications. It supports point-to-point, hubbing, DS1/DS3/EC-1 add/drop, STS-1 drop applications, ring networks, OC-1 extensions, and upgrade to OC-12.

The DDM-2000 OC-3 Multiplexer is designed for easy installation and operation. Centralized operation is supported by a full set of single-ended operations (SEO), control and maintenance features. Integrated test capabilities and default provisioning simplifies installation. Most tasks can be performed using faceplate LED displays and controls, while a CIT gives access to sophisticated maintenance, provisioning, and reporting features. A PC is needed to download software and to run CPro-2000 graphical user interface tool software.

Built-in maintenance capabilities support both installation and system operation. A DDM-2000 OC-3 Multiplexer can be fully tested and installed without external test equipment.

The DDM-2000 OC-3 Multiplexer has a phased release plan. This manual covers Releases 2 through 15. The manual will be updated to cover additional releases as they become available.

The Year 2000

DDM-2000 Multiplexers will not be affected by the arrival of the year 2000.

DDM-2000 OC-3 Multiplexer Releases

Release Descriptions

The following paragraphs provide brief descriptions of the DDM-2000 OC-3 Multiplexer releases. Some software releases are no longer available, refer to Section 7, “Software Ordering” for availability of software releases.

Release 2 and later features allow additional circuit pack configurations to activate hubbing and STS-1 linear drop applications. The TL1 message-based interface to Telcordia Technologies Network Monitoring and Analysis (NMA) operations system feature comes as part of the controller hardware and software which must always be furnished separately with Release 2 and later equipment.

Release 3.2 features includes three circuit packs (and associated software): the 22F intermediate reach optical line interface unit (OLIU) which provides full DS1 and DS3 add/drop capability; the 21D OLIU which provides a short-reach multimode proprietary optical interface (IS-3) between the OC-3 and OC-12 shelves; and the BBF2B TGS circuit pack which provides DS1 timing outputs. The DS1 timing output is derived from the OC-3 signal. Release 3 includes a security feature that offers security against unauthorized access to the CIT system functions. Logins, passwords, and user categories are provided. Security can be enabled or disabled.

Release 5.1 supersedes Release 5.0 (from this release on, odd feature numbers are for ring releases while even feature numbers are for linear releases) and is a two-fiber, virtual tributary (VT) path switched, ring release that requires the use of 22F OLIUs in the Main-1 and Main-2 slots of all shelves in the ring. Time slots must be reserved all the way around the ring limiting the ring capacity to 84 DS1s. The ring interfaces include DS1 low-speed, DS3 with STS-1 path protection switching and cross-connections, EC-1 low-speed with VT1.5 or STS-1 based cross-connections, or mixed DS1, DS3, and EC-1 interfaces with a total capacity not exceeding the OC-3 bandwidth.

Release 5.1 features include two circuit packs (and associated software): the BBF3 DS1PM which provides DS1 performance monitoring and the BBG6 STS1E (EC-1) provisioned for low-speed operation. The DS1PM can be mixed with the DS1 circuit packs in the Low-Speed Group slots. The optional DS1PM feature allows measuring of near-end performance and the extended superframe (ESF) far-end performance report of the incoming DS1 signal. This allows the service provider to determine the end-to-end performance of the DS1 signal. SONET synchronization messaging is used to communicate the quality of network timing, internal timing status, and timing states throughout a subnetwork.

Release 6.0 supports linear applications with features that include OC-3/OC-12 interworking using the open systems interconnection (OSI) seven-layer protocol stack over the data communications channel (DCC). The OSI seven-layer protocol stack refers to the OSI reference model, a logical structure for network operations standardized by the International Standards Organization (ISO). Release 6.0 also includes an optional optical carrier level 3 concatenated (OC-3c) feature provided by the 21D or 21G OLIU. This OC-3c transport feature is used to interface with broadband terminals.

Release 6.0 includes one circuit pack (and associated software): the BBG6 STS1E which provides a high-speed or low-speed EC-1 interface. The STS1E circuit packs are used in the Function Unit slots for EC-1 electrical multiplexer (high-speed) or EC-1 low-speed applications. The optional VT1.5 PM feature provides the PM of the V5 byte for errored seconds (ES), severely errored seconds (SES), and unavailable seconds (UAS). The optional DS1 PM feature allows measuring of near-end performance and the ESF far-end performance report of the incoming DS1 signal. This allows the service provider to determine the end-to-end performance of the DS1 signal. Enhanced security features include additional logins. The TL1 message based interface, introduced in Release 2.0 and enhanced in subsequent releases for centralized surveillance by NMA systems is enhanced in this release to allow Telcordia Technologies OPS/INE system to provide centralized flow-through provisioning of ports and cross-connections.

Release 6.2 replaces Release 6.x and includes linear optical extensions from an OC-3 ring and an automatic synchronization reconfiguration feature. Automatic synchronization reconfiguration provides the ability to automatically select another synchronization source and to automatically reconfigure the synchronization provisioning in the event of a synchronization source failure or a synchronization change in the network, for example, a fiber cut. The feature can be enabled or disabled. Additional TL1 messages support provisioning, maintenance, testing, performance monitoring, and security functions.

Release 6.2 includes *SLC*-2000 Release 3.1 and 3.2 interworking and channel state provisioning. Channel state provisioning is a capability provided on DDM-2000 Multiplexers that suppresses reporting of alarms and events during provisioning by supporting multiple states (automatic, in-service, and not-monitored) for VT1.5 and STS-1 channels.

Release 7.0 is an enhanced ring release. Release 7.0 supports a "drop and continue" feature which is used with dual ring interworking (DRI) applications and an automatic synchronization reconfiguration feature. Release 7.0 features include two plug-ins (and associated software): the 22D-U and the 22G-U OLIUs. The 22D-U OLIU provides a short-reach IS-3 with TSI optical interface between colocated OC-3 and OC-12 and *SLC*-2000 ring shelves. The 22G-U OLIU has the same functionality of the 22F OLIU but with a 23 dB outside plant loss budget allowing for spans of up to 51 km. The 22D-U and 22G-U OLIUs support signal

degrade protection switching. The "U" designation for the 22D-U and 22G-U OLIUs means the OLIUs have **U**niversal optical connectors. These OLIUs have adapters that allow the use of SC, FC, or *ST* ® connectors on the faceplates. The 22D-U and 22G-U OLIUs can be used in all releases that currently support 22F OLIUs (Release 3.1 and later).

Release 7.1 is an enhanced ring release featuring interworking with an OC-12 ring and interworking with *SLC*-2000 Releases 3.1 and 3.2 in a ring. Release 7.1's features include channel state provisioning, STS-1 signal degrade protection switching, OC-12 VT1.5 path switched ring (ring 0x1 low-speed interface) optical interconnections between DDM-2000 OC-3 and OC-12 ring shelves (OC-3/IS-3), enhanced DS3 PM, and additional TL1 commands and enhancements.

Channel state provisioning is a capability provided on DDM-2000 OC-3 and OC-12 Multiplexers that suppresses reporting of alarms and events during provisioning by supporting multiple states (automatic, in-service, and not-monitored) for VT1.5 and STS-1 channels. The STS-1 signal degrade feature requires the 22G-U or 22D-U OLIUs and measures the BIP-8 (B3) parity violations and causes a protection switch to the alternate path if the provisioned bit error rate (BER) threshold is crossed. The OC-12 VT1.5 path switched ring (ring 0x1 low-speed interface) OC-3/IS-3 interface offers a significant advantage over the 1+1 protected OC-3/IS-3 interface for VT1.5 path switched ring applications. Ring (0x1) low-speed interface means two service lines (no protection lines) are used between the OC-12 Multiplexer ring and the OC-3 Multiplexer ring. Switching is not done on the DDM-2000 OC-12 Multiplexer; rather VT1.5 or STS-1 level switching is done at the DDM-2000 OC-3 Multiplexer.

Enhanced DS3 PM provides a collection (from the fiber or high-speed interface) of the DS3 parity-bit (P-Bit) and frame and multiframe (F&M) bit errored seconds, severely errored seconds, and unavailable seconds to the already provided coding violations and severely errored frame seconds. The feature is mainly used for DS3 tariff verification.

Release 7.2 is a ring release that provides OC-3 operations interworking with the FT-2000 OC-48 Lightwave System. It also allows interworking between the old controllers (BBG5 and BBG7) and the controllers (BBG8 and BBG9). DDM-2000 FiberReach (OC-1) extensions can be added to Release 7.1 rings by upgrading the rings to Release 7.2 and adding a Release 9.0 OC-3 host node. Only OC-3 DDM-2000 FiberReach host nodes need Release 9.0 software and the controllers.

- Applications:
  - OC-3 operations interworking with FT-2000 OC-48 Lightwave System. Single-ended operations and DCC connectivity supported over OC-3 interfaces. Requires FT-2000 OC-48 Lightwave System Release 6.0 software.

- OC-3/IS-3 DRI with VT1.5/STS-1 drop and continue. Single-ended operations and DCC connectivity between DDM-2000 systems or DDM-2000 and FT-2000 OC-48 Lightwave Systems in DRI applications.
- Increased subnetwork size. DDM-2000/*SLC*-2000/FT-2000 OC-48 Lightwave System subnetworks of 24 NEs.

■ Features:

- Multiple Operations System (OS) Gateway Network Element (GNE). In DDM-2000/*SLC*-2000 networks, more than one NE can be physically connected to X.25 allowing OSs to automatically select an alternate GNE in case of primary GNE failure. The feature also allows different GNEs to support different OSs simultaneously.
- Provisionable X.25 packet size of 128 or 256 bytes.
- Enhanced PM. Enhancements to DS1 and DS3 line and path PM to further support tariff verification. Enhanced DS3 PM requires the BBG4B DS3 circuit pack.
- CPro-2000, ITM SNC. Release 7.2 is supported by:

  CPro-2000 Releases R3.0, 4.0, 5.0, 6.0, 6.1, and 6.2; ITM SNC Releases 2.2, 3.0, 4.0, 5.0, 6.0, 8.0, 9.0, and 10.0.

Release 8.0 is a linear release using the BBG8 system controller and BBG9 overhead controller circuit packs.

■ Applications:

- OC-3 operations interworking with FT-2000 OC-48 Lightwave System. Single-ended operations and DCC connectivity supported over OC-3 interfaces. Requires FT-2000 OC-48 Lightwave System Release 6.0 software.
- OC-3/IS-3 linear extensions from OC-12 rings. 1+1 linear OC-3 and IS-3 extensions from OC-12 rings.
- Increased subnetwork sizes. DDM-2000/*SLC*-2000 subnetworks of 32 NEs. DDM-2000/*SLC*-2000/FT-2000 OC-48 Lightwave System subnetworks of 24 NEs.

■ Features:

- Multiple Operations System (OS) Gateway Network Element (GNE). In DDM-2000/*SLC*-2000 networks, more than one NE can be physically connected to X.25 allowing OSs to automatically select an alternate GNE in case of primary GNE failure. The feature also allows different GNEs to support different OSs simultaneously.
- Additional X.25 switched virtual circuits. Nine virtual circuits can be provisioned in any combination of switched and permanent virtual circuits for connections to OSs.

— Provisionable X.25 packet size of 128 or 256 bytes.

— Centralized operations over X.25 link. DDM-2000 CIT commands have equivalent TL1 commands. This allows centralized operations of DDM-2000 systems via the TL1/X.25 link as an alternative to CIT commands.

— Controllers. The BBG8 and BBG9 controller circuit packs provide expanded memory and processing capacity needed to support large networks. Feature enhancements available with the controllers include:

  - Remote software download. Software can be downloaded from a PC connected to a DDM-2000/*SLC*-2000 NE to either the local or remote DDM-2000/*SLC*-2000 NE.
  - Electronic provisioning. Elimination of DIP switches. Provisionable parameters are set by software, thus eliminating DIP switches. CIT baud rate is provisioned automatically via autobaud detection.
  - User-assigned RT miscellaneous discretes increased from 15 to 21.
  - Upgrades to the controllers can be done in service.

— Enhanced PM. Enhancements to DS1 and DS3 line and path PM to further support tariff verification. Enhanced DS3 PM requires the BBG4B DS3 circuit pack.

— Enhanced security. General and reports-only users increased from 50 to 100. Lockout of nonpriviliged users and log of all login attempts is provided.

— Electrical facility loopbacks. DS3, and EC-1 equipment loopbacks of the incoming low-speed signal back towards the DSX.

— STS path trace. Provided in the J1 byte of the SONET path overhead to verify STS path continuity. Allows "labeling" of STS-1s and retrieval of the path by the "label" (for example, "ABC #1"). STS path trace requires the BBG4B DS3 circuit pack.

— Provisionable AIS and unequipped conditions. Line or path AIS provisionable on a path basis. Provides detection and alarming of path unequipped condition.

Provides user provisionable generation of AIS or path unequipped signal on a per-shelf basis. Useful in managing cross-connection provisioning if cross-connections are inadvertently deleted.

— CPro-2000, ITM SNC. Release 8.0 is supported by:

CPro-2000 Releases 4.0, 5.0, 6.0, 6.1, and 6.2; ITM SNC Releases 2.2, 3.0, 4.0, 5.0, 6.0, and 8.0.

Release 8.1 provides all of the features of Release 8.0 and is a linear release supporting *MegaStar* 2000 SONET Radio. Release 8.1 requires the BBG8 SYSCTL system controller and BBG9 or BBG10 OHCTL overhead controller. Release 8.1 may be used for non-*MegaStar* 2000 applications when S1 byte synchronization messaging is desired. Release 8.1 will interwork with Releases 7.2 or 9.0.

- Applications:
  - *MegaStar* 2000 SONET Radio. Part of Lucent Technologies and Harris-Farinon *MegaStar* 2000 Radio system supporting mixed fiber and radio topologies. *MegaStar* applications require the BBG10 OHCTL.
- Features:
  - S1 Byte synchronization messaging. Uses the S1 byte of the SONET overhead to pass timing status information to different nodes in a loop-timed network. Synchronization messaging mode (S1 byte or K2 byte) is provisionable on a per OC-N basis.
  - CPro-2000, ITM SNC. Release 8.1 is supported by:

    CPro-2000 Releases 5.0, 6.0, 6.1, and 6.2; ITM SNC Releases 3.0, 4.0, 5.0, 6.0, 8.0, 9.0, and 10.0.

Release 9.0 provides all of the features of Release 7.2 and is a ring release using the BBG8 SYSCTL system controller and BBG9 OHCTL overhead controller circuit packs.

- Applications:
  - OC-3 DDM-2000 FiberReach host. An OC-3 shelf equipped with 27G-U dual OC-1 OLIUs that supports OC-1 ring extensions from an OC-3 ring, linear, or stand-alone network.
  - Automatic synchronization reconfiguration of timing from both Main and Function Unit C slots.
  - Increased subnetwork sizes. DDM-2000/*SLC*-2000 subnetworks of 32 NEs. DDM-2000/*SLC*-2000/FT-2000 OC-48 Lightwave System subnetworks of 24 to 32 NEs.
  - VT hairpin. Cross-connections are allowed between Function Unit A to Function Unit C and Function Unit B to Function Unit C. Optical extensions from Function Unit A slots are also allowed.
  - Dual homing. Ring (0x1) low-speed interface cross-connections between Main and Function Unit slots for dual homing applications between DDM-2000 OC-3 Multiplexers and DDM-2000 FiberReach.

  - Locked cross-connections. Ring (0x1) low-speed interface or VT locked cross-connections between low-speed and high-speed time slots, locking ring traffic onto a designated ring rotation. Used in utility market applications.

- Features:
  - Additional X.25 switched virtual circuits. Nine virtual circuits can be provisioned in any combination of switched and permanent virtual circuits for connections to OSs.
  - Centralized operations over X.25 link. DDM-2000 CIT commands have equivalent TL1 commands. This allows centralized operations of DDM-2000 systems via the TL1/X.25 link as an alternative to CIT commands.
  - Controllers. The BBG8 and BBG9 controller circuit packs provide expanded memory and processing capacity needed to support large networks. Feature enhancements available with the controllers include:
    - Remote software download. Software can be downloaded from a PC connected to a DDM-2000/*SLC*-2000 NE to either the local or remote DDM-2000/*SLC*-2000 NE.
    - Electronic provisioning. Elimination of DIP switches. Provisionable parameters are set by software, thus eliminating DIP switches. CIT baud rate is provisioned automatically via autobaud detection.
    - User-assigned RT miscellaneous discretes increased from 15 to 21.
    - Upgrades to the BBG8 and BBG9 controllers can be done in service.
  - Enhanced PM. Enhancements to DS1 and DS3 line and path PM to further support tariff verification. Enhanced DS3 PM requires the BBG4B DS3 circuit pack.
  - Enhanced security. General and reports-only users increased from 50 to 100. Lockout of nonpriviliged users and log of all login attempts provided.
  - Electrical facility loopbacks. DS3, and EC-1 equipment loopbacks of the incoming low-speed signal back towards the DSX.
  - STS path trace. Provided in the J1 byte of the SONET path overhead to verify STS path continuity. Allows "labeling" of STS-1s and retrieval of the path by the "label" (for example, "ABC #1"). STS path trace requires the BBG4B DS3 circuit pack.

- Provisionable AIS and unequipped conditions. Line or path AIS provisionable on a path basis. Provides detection and alarming of path unequipped condition.

  Provides user provisionable generation of AIS or path unequipped signal on a per-shelf basis. Useful in managing cross-connection provisioning if cross-connections are inadvertently deleted.

- OC-1 line state provisioning. A capability provided on DDM-2000 OC-3 Multiplexers that suppresses reporting of alarms and events by supporting multiple states (in-service and not monitored) for OC-1 low-speed interfaces.

- CPro-2000, ITM SNC. Release 9.0 is supported by:

  CPro-2000 Releases 3.0, 4.0, 5.0, 6.0, 6.1, and 6.2; ITM SNC Releases 2.2, 3.0, 4.0, 5.0, 6.0, and 8.0.

Release 9.1 is a ring release which provides all the features of Release 9.0 and requires the BBG8 and BBG9 or BBG10 controller hardware. In addition, Release 9.1 supports the following applications and features:

- Applications:
  - *MegaStar* 2000 SONET Radio. Part of Lucent Technologies and Harris-Farinon *MegaStar* 2000 Radio system supporting mixed fiber and radio topologies. *MegaStar* 2000 applications require BBG10 OHCTL.
  - Extended FiberReach topologies. Using the 27G2-U OLIU and Release 2.0 or 2.1 of FiberReach, Release 9.1 supports:
    - Hairpin single and dual 0x1 cross-connects between OC-1s within the same 27G2-U OLIU.
    - Hairpin single and dual 0x1 cross-connects between 27G2-U OLIUs in different function units.
    - Pass-through cross-connects for an OC-1 ring terminated on 27G2-U OLIUs in a function unit.
    - Mixing of all supported cross-connect types.
- Features:
  - S1-byte Synchronization Messaging. Uses the S1 byte of the SONET overhead to pass timing status information to different nodes in a loop-timed network. Synchronization messaging mode (S1 byte or K2 byte) is provisionable on a per OC-3 basis.
  - Enhanced DS1 PM. Provides 15-minute bins for DS1 path and line performance monitoring data.

- — 4th Level of Security. A Maintenance security level, which allows access to Reports and some maintenance activities is provided in addition to the 3 current levels of privileged, general, and reports-only.
- — Enhanced software download. Provides a software copy capability allowing compressed files containing the software generic to be downloaded to the DDM-2000 system while the current version is still running. When the appropriate command is initiated, the new generic is executed.
- — Quad-DS1 electrical loopbacks. Provides an electrical facility loopback of four DS1 interfaces from a given BBF1B or BBF3 DS1 circuit pack.
- — Large networks. Supports DDM-2000 and FiberReach networks of up to 50 nodes.
- — 27G2-U OLIU. The 27G2-U OLIU supports the cross-connects necessary to provide enhanced FiberReach topologies.
- — CPro-2000, ITM SNC support. Release 9.1 is supported by:

  CPro-2000 Releases 5.0, 6.0, 6.1, and 6.2; ITM SNC Releases 2.2, 3.0, 4.0, 5.0, 6.0, and 8.0.

Release 11.0 is an enhanced ring release which provides all the features of Release 9.1. In addition, Release 11.0 supports the following applications and features:

- ■ Applications:
  - — OC-12 high-speed optics from OC-3 shelf. Increases ring capacity by providing low-speed DS1 and FiberReach services directly from an OC-12 ring via the OC-3 shelf. Minimizes need for back-to-back equipment. Supports mixing of OC-3 and OC-12 shelves on the same ring.
  - — Enhanced FiberReach topologies. Supports a hairpin local drop of traffic from an OC-1 ring terminated on 27G2-U OLIUs in a function unit to a DS1/EC-1/OC-3 interface in the other function unit group. The 27G2-U is required for these applications. Also supports mixing of local drop, pass-through, and 0x1 cross-connect types.
  - — Multi-media Data Services: A DS3 interface provides the flexibility to offer a full range of multi-media data services via embedded and new DDM-2000 networks. This full-solution offering is made possible by interfacing DDM-2000 to any of the numerous commercially available data edge devices which provide the various data services interfaces.

- — Native Mode LAN Interface. By deploying DDM-2000 with an adjunct LAN router/ATM switch, Release 11.0 provides a Native Mode LAN Interface. DDM-2000 offers up to 4 LAN ports per STS-1 of bandwidth. Point-to-point and point-to-multi-point service is provided. In a later release, this functionality will be integrated directly in the DDM-2000 shelf.

- ■ Features:
  - — OC-12 OLIU (24G-U) for OC-3 shelf. The 24G-U OLIU provides OC-12 optics directly from the DDM-2000 OC-3 shelf. This allows the OC-3 shelf to support and OC-12 ring, with the low-speed inputs and capacity of the OC-3 shelf. The 24G-U OLIU provides visibility to the full STS-12 bandwidth, and allows for selection of any STS-1/DS1 traffic from any 3 STS-1 on the OC-12 ring for drop at the OC-3 shelf. Remaining traffic is passed back to the OC-12 ring.
  - — Data Services Interface. A DS3 circuit pack and cross-connect software provide the DDM-2000 interface to an external LAN router/ATM switch for providing Native Mode LAN or general data services via the SONET network.
  - — Enhanced software download. Provides a software copy capability allowing compressed files containing the software generic to be downloaded to the DDM-2000 system. This can be done while the current version is still running. When the appropriate command is initiated, the generic is executed. Execution of the generic can be scheduled (time and date), allowing coordination of cutover of several NEs in the subnetwork.
  - — CPro-2000, ITM SNC support. Release 11.0 is supported by:

    CPro-2000 Releases 6.0, 6.1, and 6.2; ITM SNC Releases 4.0, 5.0, 6.0, 8.0, 9.0, and 10.0.

Release 11.1 is an enhanced ring release which provides all the features of Release 11.0. In addition, Release 11.1 supports the following applications and features:

- ■ Applications:
  - — Enhanced FiberReach topologies. Supports enhanced routing with the single OC-1 26G2-U OLIU. The 26G2-U, with built-in multiplexer capabilities, can drop DS1s without the need for the MXRVO Multiplexer or BBF5 Jumper circuit packs. The 26G2-U provides OC-1 ring pass-through, OC-1 ring hairpin single-homed and dual-homed, and OC-1 ring hairpin local drop applications.
  - — Transmultiplexer DS3 path termination. The TMUX circuit pack (BBG20) provides path termination functions for an M13 or C-bit parity DS3 signal. It demultiplexes the DS3 into 28 DS1s, performs DS1 PM, maps each DS1 into a VT1.5, and multiplexes the 28 VT1.5s into an STS-1.

- — High bit rate Digital Subscriber Line (HDSL). The HDSL circuit pack (BBF8) provides HDSL interface capability on the DDM-2000 OC-3 shelf. It allows the transport of T1 payloads, for up to 12,000 feet, over two metallic 24 AWG twisted-pair lines.*
- — Interworking with Tellabs *TITAN* † 5500/S Release 5.0 Digital Cross-Connect System.

■ Features:

- — STS-1 hairpin cross-connection.
- — Single DS1 facility loopback.
- — Intermediate node STS performance monitoring. This feature collects, reports, and thresholds PM status for the SONET STS-1 Path (B3) derived parameters at intermediate Network Element interfaces.
- — Alarm severity escalation. Allows the user to provision (enable/disable) the alarming of service affecting/non-service affecting entities.
- — CPro-2000, ITM SNC support. Release 11.1 is supported by:

  CPro-2000 Release 6.1 and 6.2; ITM SNC Release 6.0, 8.0, 9.0, and 10.0.

Release 13.0 is an enhanced ring release which provides all the transmission features of Release 11.0. In addition, Release 13.0 supports the following applications and features:

■ Applications:

- — Enhanced FiberReach topologies. Supports enhanced routing with the single OC-1 26G2-U OLIU. The 26G2-U, with built-in multiplexer capabilities, can drop DS1s without the need for the MXRVO Multiplexer or BBF5 Jumper circuit packs. The 26G2-U provides OC-1 ring pass-through, OC-1 ring hairpin single-homed and dual-homed, and OC-1 ring hairpin local drop applications.
- — Transmultiplexer DS3 path termination. The TMUX circuit pack (BBG20) provides path termination functions for an M13 or C-bit parity DS3 signal. It demultiplexes the DS3 into 28 DS1s, performs DS1 PM, maps each DS1 into a VT1.5, and multiplexes the 28 VT1.5s into an STS-1.

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* The HDSL circuit pack can also be installed in DDM-2000 OC-3 shelves running linear Releases 6.2 and later, and ring Releases 7.1 and later. Refer to information included with each circuit pack for provisioning instructions.

† *TITAN* is a trademark of Tellabs, Inc.

- — High bit rate Digital Subscriber Line (HDSL). The HDSL circuit pack (BBF8) provides HDSL interface capability on the DDM-2000 OC-3 shelf. It allows the transport of T1 payloads, for up to 12,000 feet, over two metallic 24 AWG twisted-pair lines.*
- — Interworking with Tellabs *TITAN* † 5500/S Release 5.0 Digital Cross-Connect System.

- Features:
  - — Multi-Vendor Operations Interworking (OI) compatibility.
    - DDM-2000 is compatible with any other-vendor NEs that support Target ID Address Resolution (TARP) protocol, OSI, IAO LAN, and TL1/X.25 as specified in Telcordia Technologies GR-253.
    - Compatible with Tellabs *TITAN* 5500/S Release 5.0 Digital Cross-Connect System, including TL1 OS access.
  - — Lucent 2000 Product Family OI compatibility.
    - Compatible with FT-2000 R8.0 (but not with earlier releases due to multi-vendor OI support).
  - — Large subnetworks.
    - Supports large subnetworks of up to 256 NEs by partitioning into multiple areas connected via Level 2 Intermediate Systems (IS).
  - — IntrAOffice LAN (IAO LAN).
    - Provides an extension of the SONET DCC for operations data communications. All NE-to-NE features supported over the DCC are supported over the IAO LAN.
    - Supports ITM SNC software download to DDM-2000‡
    - Supports ITM SNC as the TL1-GNE.
  - — STS-1 hairpin cross-connection.
  - — Single DS1 facility loopback using the BBF3B circuit pack.

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* The HDSL circuit pack can also be installed in DDM-2000 OC-3 shelves running linear Releases 6.2 and later, and ring Releases 7.1 and later. Refer to information included with each circuit pack for provisioning instructions.

† *TITAN* is a trademark of Tellabs, Inc.

‡ This feature will be useful when upgrading from DDM-2000 OC-3 R13.0 and OC-12 R7.0 to later releases.

— Intermediate node STS performance monitoring. This feature collects, reports, and thresholds PM status for the SONET STS-1 Path (B3) derived parameters at intermediate Network Element interfaces.

— Alarm severity escalation. Allows the user to provision (enable/disable) the alarming of service affecting/non-service affecting entities.

— CPro-2000, ITM SNC support. Release 13.0 is supported by:

CPro-2000 Release 7.0, 8.0, 9.0, 10.0, 11.1; ITM SNC Release 5.0, 6.0, 8.0, 9.0, and 10.0.

Release 15.0 is an enhanced ring release which provides all the transmission features of Release 13.0. In addition, Release 15.0 supports the following applications and features:

- New Applications:
  - IMA LAN Interface. With the introduction of a new low-speed circuit pack, Release 15.0 provides a direct IMA LAN to WAN interface through the DDM-2000 OC-3.
    - The IMA LAN (BBF9 metallic or BBF10 optical) circuit pack provides an interface for one 10/100BaseT, 100BaseFX IEEE 802.3 standard compliant interface.
  - T1 Interface. The T1EXT (BBF6) circuit pack provides line termination for two bi-directional T1 line interfaces. Signals received from the T1 interface are mapped into SONET VT1.5 signals. The resulting signals are routed to the OLIU circuit packs. The T1EXT circuit pack is used only with the enhanced MXRVO (BBG2B) circuit pack in Group 4 shelves. Requires separate secondary lightning and surge protection in outside plant applications.
  - STS-3c 0x1 Configuration. This application provides the ability of transporting STS-3c services on OC-3c low speed FUNCTION UNITS optical interfaces that have been provisioned for 0x1 with 29G-U/29H-U OLIUs in MAIN and 22-Type OLIUs in FUNCTION UNITS slots. STS-3c routing is restricted to FUNCTION UNITS C.
  - STS-1/VT1.5 0x1 Configuration. This application provides the ability of transporting STS-1 services on OC-3 low speed FUNCTION UNITS optical interfaces that have been provisioned for 0x1 with 29/24/22-Type OLIUs in MAIN and 22-Type OLIUs in FUNCTION UNITS slots of the host OC-3 shelf.

- New Features:
  - — Support the OC-12 optics through the 29G-U/29H-U OLIU circuit packs in the Main Unit slots. The related features are as follows.
    - STS-1/STS-3c/VT1.5 pass-through cross-connections on the 29G-U/29H-U OC-3 equipped shelves.
    - STS-1 and VT1-5 cross-connections between MAIN slots equipped with the 29G-U/29H-U OLIU and FUNCTION UNITS slots, providing a fully flexible assignment of VT and STS-1 timeslots out of any of the 12 STS-1s that are available on the 29-type OLIU. STS-3c cross-connections to FUNCTION UNITS C only.
    - In-service upgrades to the new 29G-U/29H-U OLIU.
  - — Stratum 3 timing generator circuit pack (BBF4). The TG3 operates with an internal oscillator of ±4.6 ppm long-term accuracy.
  - — Support DCC provisioning on MAIN (identical) for OC-3/OC-12 ring interface. This will allow a remote OC-3 shelf to interconnect through its MAIN ring interfaces with a 1+1 linear extension on a host OC-3, OC-12, or OC-48 shelf using ring software.
  - — Support the provisioning of asynchronous CIT port to run TL1, as well as the provisioning of the synchronous X.25 port to be used for asynchronous TL1 interface.
  - — Remote alarm status (using the AGNE and the Alarm Group concept).
  - — CPro-2000, ITM SNC support. Release 15.0 is supported by:

    CPro-2000 Releases 10.0 and 11.1; ITM SNC Release 10.0.
  - — Software download to upgrade BBF9 and BBF10 IMA LAN circuit pack.

Introduction to the DDM-2000 OC-12 Multiplexer

The DDM-2000 OC-12 Multiplexer is a single shelf SONET digital multiplexer. A single 12-inch shelf supports a mix of DS3 and OC-3 signals and multiplexes them into a SONET standard 622 Mb/s OC-12 rate.

The OC-12 and OC-3 optical lines, all transmission-affecting circuit packs, and the –48 V DC power feeders may be optionally protected. The shelf can be equipped to serve many diverse network applications and supports a variety of operations interfaces for current and evolving network operations needs.

The DDM-2000 OC-12 Multiplexer is designed for loop (access), interoffice (transport), and customer location applications. The DDM-2000 OC-12 Multiplexer starts with many of the proven features of Lucent's DDM-1000 and DDM-2000 OC-3 Multiplexers and extends into the future with the flexibility of the SONET standard.

The DDM-2000 OC-12 Multiplexer is designed for easy installation and operation. Installation is simplified with integrated test capabilities and default provisioning. Centralized operation is supported by a full set of single-ended control and maintenance features. Built-in maintenance capabilities support both installation and system operation. A DDM-2000 OC-12 Multiplexer can be fully tested and installed without using external test equipment. Most tasks can be performed using faceplate LED displays and controls, while a CIT gives access to sophisticated maintenance, provisioning, and reporting features. A PC is needed to download software and to run CPro-2000 graphical user interface tool software.

The OC-12 Regenerator extends the span length of the DDM-2000 OC-12 Multiplexer and is supported in both unbalanced and balanced modes. Diverse routing is supported in either mode, allowing one line to travel over a longer route than the other. The OC-12 Regenerator uses the same shelf and some of the same circuit packs as the OC-12 Multiplexer. The OC-12 Regenerator has been classified discontinued availability (DA).

The DDM-2000 OC-12 Multiplexer has a phased release plan. This manual covers Releases 1 through 3, 5.1, 5.2, and 7.0 of the DDM-2000 OC-12 Multiplexer and Release 2 of the OC-12 Regenerator. The manual will be updated to cover additional releases as they become available.

DDM-2000 OC-12 Multiplexer Releases

Release Descriptions

The following paragraphs provide brief descriptions of the DDM-2000 OC-12 Multiplexer releases. Some software releases are no longer available, refer to Section 8, “Software Ordering” for availability of software releases.

Release 1.0 and later features include OC-12 point-to-point with DS3 low-speed interfaces, OC-12 hubbing with OC-3 extensions, and OC-3/OC-12 interworking using the 21D OLIU. The TL1/X.25 message-based interface to Telcordia Technologies NMA OS feature comes as part of the controller hardware and separately ordered software required with Release 1.1 and later equipment. Hardware features include the 21D OLIU, which provides a short-reach multimode proprietary optical interface (IS-3) between the OC-3 and OC-12 shelves and the BBF2B TGS circuit pack, which provides DS1 timing outputs. Release 1.0 includes a security feature that offers security against unauthorized access to the CIT system functions. Logins, passwords, and user categories are provided. Security can be enabled or disabled.

Release 2.0’s features include OC-3/OC-12 interworking using the open systems interconnection (OSI) seven-layer protocol stack over the DCC. The OSI seven-layer protocol stack refers to the OSI reference model, a logical structure for network operations standardized by the ISO. Release 2.0 also includes optical carrier level 3 concatenated (OC-3c) transport. This OC-3c transport feature can be used to interface with broadband terminals using 21D or 21G OLIUs.

SONET synchronization messaging is used to communicate the quality of network timing, internal timing status, and timing states throughout a subnetwork. The OC-12 23H/23H-U OLIU provides 1550 nm optics for long reach (100 km) central office applications.

Release 2.1’s applications include DDM-2000 OC-12/DACS IV-2000 transmission interworking with an EC-1 interface, DDM-2000 OC-12/FT-2000 OC-48 Lightwave System transmission interworking with an EC-1 interface, and OC-12 linear extensions from OC-3 rings. Features include an EC-1 interface with a BBG12 3STS1E low-speed interface circuit pack, TL1 interface to Telcordia Technologies Operations Systems/Intelligent Network Elements (OPS/INE) Release 1.7, and additional TL1 messages to support provisioning, maintenance, testing, performance monitoring, and security functions.

Release 2.2’s applications and features include interworking with *SLC*-2000 Release 3.0, channel state provisioning, and additional TL1 commands and enhancements.

Channel state provisioning is a capability provided on DDM-2000 OC-12 Multiplexers that suppresses reporting of alarms and events by supporting multiple states (automatic, in-service, and not monitored) for STS-1 channels.

Release 2.3 provides OC-3 line state provisioning in addition to the features of Release 2.2. Line state provisioning allows in-service and not-monitored states of OC-3 line level alarms on Function Unit OLIUs. The alarms can be squelched and removed from the alarm report. This feature may be used in one-way OC-3c transport on OC-12 video applications.

Release 3.0 is an OC-12 STS-1 path switched ring release featuring EC-1 DRI with drop and continue and automatic synchronization reconfiguration. Applications include OC-12 path switched ring, DDM-2000 OC-12/DACS IV-2000 transmission interworking, and DRI interworking via an EC-1 interface. Features include DS3 low-speed interface on an OC-12 path switched ring, EC-1 low-speed interface with the BBG12 3STS1E circuit pack, two-fiber path switched ring, ten NE maximum network from a single maintenance point, STS-1 drop and continue, nonrevertive protection switching, automatic ring synchronization reconfiguration, OSI seven-layer protocol stack on the DCC in a ring, DS1 timing outputs for timing distribution, synchronization messaging, STS-1 signal degrade, manual STS path switching, enhanced security, remote and remote software download. The BCP3 time slot interchange (TSI FLEX) circuit pack provides flexible STS-1 bandwidth management across the entire OC-12.

Release 3.1's applications and features include interworking with *SLC*-2000 Releases 3.1 and 3.2 ring networks, OC-12 STS-1/VT1.5 path switched ring (ring 0x1 low-speed interface) optical interconnections between DDM-2000 OC-3 and OC-12 ring shelves (OC-3/IS-3), enhanced DS3 PM, channel state provisioning, OC-3 ring to OC-12 ring inservice upgrades, low-speed EC-1 loopbacks, and additional TL1 commands and enhancements.

The OC-12 STS-1/VT1.5 path switched ring (ring 0x1 low-speed interface) OC-3/IS-3 interface offers a significant advantage over the 1+1 protected OC-3/IS-3 interface for VT1.5 path switched ring applications. Ring (0x1) low-speed interface means two service lines (no protection lines) are used between the OC-12 Multiplexer ring and the OC-3 Multiplexer ring.

Ring 0x1 low-speed interfaces provide full VT protection switching via an OC-12 ring, bandwidth conservation, and VT bandwidth management on the OC-12 ring.

Enhanced DS3 PM provides a collection (from the fiber or high-speed interface) of the DS3 parity-bit (P-Bit) and frame and multiframe (F&M) bit errored seconds, severely errored seconds (SES), and unavailable seconds (UAS) to the already provided coding violations and severely errored frame seconds (SESF). The feature is mainly used for DS3 tariff verification.

Channel state provisioning is a capability provided on DDM-2000 OC-12 Multiplexers that suppresses reporting of alarms and events by supporting multiple states (automatic, in-service, and not-monitored) for STS-1 channels.

Electronic STS-1 loopbacks (EC-1 low-speed) are provided to loop each of the three internal STS-1 signals back toward the transmit fiber. These can be used to test a new span being added to a hub or add/drop network.

Release 5.0 is a ring release using the BBG8 system controller and BCP4 overhead controller circuit packs.

- Applications:
  - OC-3/IS-3 DRI with STS-1/STS-3c drop and continue. DDM-2000 and DDM-2000/FT-2000 OC-48 Lightwave System rings can be interconnected over OC-3, IS-3, OC-3c, or IS-3c interfaces with single-ended operations and DCC connectivity. Upgrades from EC-1 DRI to OC-3/IS-3 DRI.
  - OC-3/IS-3 linear optical extensions. 1+1 protected OC-3/IS-3 linear optical extensions from OC-12 rings.
  - OC-3c transport for broadband services.
  - OC-3 operations interworking with FT-2000 OC-48 Lightwave System. Single-ended operations and DCC connectivity supported over OC-3 interfaces. Requires FT-2000 OC-48 Lightwave System Release 6.0 software.
  - Dual homing. An OC-3 ring can be dual-homed to two different OC-12 shelves via ring (0x1) low-speed interface interconnections. Full DCC connectivity to the OC-3 ring.
  - Ring (0x1) low-speed interface to OC-3 multinode ring. OC-3 multinode ring is connected to an OC-12 ring shelf via ring (0x1) low-speed interface interconnection to a single OC-12 Function Unit. Full DCC connectivity to the OC-3 ring.
  - STS-3c broadcast for video applications.
  - Increased subnetwork sizes. DDM-2000/*SLC*-2000 subnetworks of 32 NEs. DDM-2000/*SLC*-2000/FT-2000 OC-48 Lightwave System subnetworks of 24 to 32 NEs.
- Features:
  - Multiple Operations System (OS) Gateway Network Element (GNE). In DDM-2000/*SLC*-2000 subnetworks, more than one NE can be physically connected to X.25 allowing OSs to automatically select an alternate GNE in case of primary GNE failure. The feature also allows different GNEs to support different OSs simultaneously.

- Additional X.25 switched virtual circuits. Nine virtual circuits can be provisioned in any combination of switched and permanent virtual circuits for connections to OSs.
- Provisionable X.25 packet size of 128 or 256 bytes.
- Centralized operations over X.25 link. DDM-2000 CIT commands have equivalent TL1 commands. This allows centralized operations of DDM-2000 systems via the TL1/X.25 link as an alternative to CIT commands.
- Controllers. The BBG8 and BCP4 controller circuit packs provide expanded memory and processing capacity needed to support large networks. Feature enhancements include:
  - Remote software download. Software can be downloaded from a PC connected to a DDM-2000/*SLC*-2000 NE to either the local or remote NEs.
  - Electronic provisioning. Elimination of DIP switches. Provisionable parameters are set by software, thus eliminating DIP switches. CIT baud rate is provisioned automatically via autobaud detection.
  - User assigned RT miscellaneous discretes increased from 15 to 21.
  - Upgrades to the controllers can be done in service.
- Enhanced PM. Enhancements to DS3 line and path performance monitoring to further support tariff verification. Enhanced DS3 PM requires the BBG11B 3DS3 circuit pack.
- Path switching and channel state provisioning for STS-3c channels.
- Line state provisioning. A capability provided on DDM-2000 OC-12 Multiplexers that suppresses reporting of alarms and events by supporting multiple states (inservice and not monitored) for OC-3 low-speed interfaces.
- Enhanced security. General and reports-only users increased from 50 to 100. Lockout of nonpriviliged users and log of all login attempts is provided.
- Electrical facility loopbacks. DS3 and EC-1 equipment loopbacks of the incoming low-speed signal back towards the DSX.
- STS path trace. Provided in the J1 byte of the SONET path overhead to verify STS path continuity. Allows "labeling" of STS-1s and retrieval of the path by the "label" (for example, "ABC #1"). STS path trace requires the BBG11B 3DS3 circuit pack.

- — Provisionable AIS and unequipped conditions. Line or path AIS provisionable on a path basis. Provides detection and alarming of path unequipped condition.

  Provides user provisionable generation of AIS or path unequipped signal on a per-shelf basis. Useful in managing cross-connection provisioning if cross-connections are inadvertently deleted.

- — CPro-2000, ITM SNC support. Release 5.0 is supported by:

  CPro-2000 Releases 3.0, 4.0, 5.0, 6.0, 6.1, and 6.2; ITM SNC Release 2.2, 3.0, 4.0, 5.0, 6.0, and 8.0.

Release 5.1 is an enhanced ring release which supports all features of R5.0. In addition, it supports the following:

- Applications:
  - — Enhanced DS3 Dual Ring Interworking.
- Features:
  - — S1 byte Synchronization Messaging. Uses the S1 byte of the SONET overhead to pass timing status information to different nodes in a loop-timed network. Synchronization messaging mode (S1 byte or K2 byte) is provisionable on a per OC-N basis.
  - — Enhanced software download. Provides a software copy capability allowing compressed files containing the software generic to be downloaded to the DDM-2000 system while the current version is still running. When the appropriate command is initiated, the generic is executed.
  - — 4th level of security. A Maintenance security level, which allows access to Reports and some maintenance activities is provided in addition to the 3 current levels of privileged, general, and reports-only.
  - — Large networks. Supports DDM-2000 and FiberReach networks of up to 50 nodes.
  - — CPro-2000, ITM SNC support. Release 5.1 is supported by:

    CPro-2000 Releases 5.0, 6.0, 6.1, and 6.2; ITM SNC Releases 2.2, 3.0, 4.0, 5.0, 6.0, 8.0, 9.0, and 10.0.

Release 5.2 is an enhanced ring release which supports all features of R5.1. In addition, it supports the following:

- — STS-3c locked 0x1 cross-connect.

Release 7.0 is an enhanced ring release which supports all features of R5.2. In addition, it supports the following:

- Applications:
  - Interworking with Tellabs *TITAN* * 5500/S Release 5.0 Digital Cross-Connect System.
- Features:
  - Target ID Address Resolution Protocol (TARP) and Telcordia Technologies compliant 2.6 standard OSI stack for intervendor operations Interworking (OI).
    - Provides for large networks up to 256 NEs via level 1 area provisioning and level 2 routing.
  - Enhanced software download. Provides a software copy capability allowing compressed files containing the new software generic to be downloaded to the DDM-2000 system. This can be done while the current version is still running without affecting the operation of the system. When the appropriate command is initiated, the new generic is executed. Execution of the new generic can be scheduled (time and date), allowing coordination of cutover of several NEs in the subnetwork.
  - IntrAOffice LAN between DDM-2000 and ITM SNC for enhanced software download and OS access.
  - Stratum 3 timing generator circuit pack (BBF4). The TG3 operates with an internal oscillator of ±4.6 ppm long term accuracy.
  - Pointer Justification Count (PJC). This performance monitoring parameter indicates a frequency error in the network or other potential synchronization problem. It provides a threshold crossing alert (TCA) when the STS-1 pointer justification count in a performance bin exceeds a user provisioned threshold value.
  - STS-3c locked 0x1 cross-connect.
  - CPro-2000, ITM SNC support. Release 7.0 is supported by:

    CPro-2000 Release 7.0, 8.0, 9.0, 10.0, and 11.1; ITM SNC Release 5.0, 6.0, 8.0, 9.0, and 10.0.

* *TITAN* is a trademark of Tellabs, Inc.

Release 7.0.4 is an enhanced ring release which supports all features of R7.0. In addition, it supports the following features:

- Remote Alarm Status
  - Alarm groups and alarm gateway: This feature partitions a network into maintenance domains (alarm groups) for alarm and status information. An alarm group is a set of NEs that shares status type information. Alarm groups can be nodes in a ring or any logical grouping such as maintenance group or geographic group.
- AGNE Communication: Every NE broadcasts its network status through the AGNE to other NEs in the same alarm group. Depending on provisioning, a member of an alarm group can:
  - List a report of the alarms and status conditions (remote alarm reports) of all members in an alarm group, and if the NE is at the CO, a member can activate the audible office alarms for the alarm group.
  - Send/receive ACO requests to and from members of the same alarm group or level 1 area.
  - Send/receive miscellaneous discrete alarm/status closure states to and from alarm group members at the CO.

OC-12 Regenerator Releases

Release Descriptions

Release 2.0 features include OC-12 Regenerator applications in the balanced or unbalanced mode, telemetry byte-oriented serial (TBOS) and parallel telemetry interfaces, enhanced maintenance with B2 performance monitoring for line bipolar-8 (BIP-8) errors, and a TL1 message-based interface.

The line parameters monitored include errored seconds, severely errored seconds, errored seconds (Type A and B), severely errored seconds (Type A and B), severely errored framing seconds, unavailable seconds, and framing violations.

Since the OC-12 Regenerator does not access the DCC, the OC-12 Regenerator software is compatible with all DDM-2000 OC-12 software releases and can be used in all OC-12 applications. The OC-12 Regenerator uses the 23R-U/23R2-U regenerator (REGENR), BBG5 system controller (SYSCTL), and BCP1 overhead controller (OHCTL) circuit packs. The 23R-U/23R2-U REGENR circuit packs have been classified discontinued availability (DA).

Features

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Features

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Overview

This section lists and briefly describes the feature highlights of the DDM-2000 OC-3 and OC-12 Multiplexers. The features are described in Section 3, "Applications," Section 4, "Product Description," and Section 5, "Operations, Administration, Maintenance, and Provisioning," as applicable.

Basic Description of DDM-2000 Product Family

DDM-2000 OC-3 Multiplexer

The DDM-2000 OC-3 Multiplexer is a synchronous optical network (SONET) standard compliant optical carrier, level 3 (OC-3) multiplexer. It multiplexes data coming into its low-speed ports and channels together to form one OC-12, one OC-3, or two OC-1 high-speed optical signals. In the opposite direction, it demultiplexes data from its high-speed port to its low-speed ports. The high-speed optical interface and time slot interchange (TSI) of the DDM-2000 OC-3 Multiplexer operates at 622 Mb/s, 155 Mb/s, or 51.84 Mb/s. It supports 84 DS1s, 42 T1s, 3 DS3s, 3 EC-1s, 3 OC-3s, 1 OC-3c, 6 OC-1s, 6 IMA LANs, or a mixture of these (up to a capacity equivalent to 84 DS1s) in its low-speed ports. When hosting FiberReach Multiplexers, the DDM-2000 OC-3 Multiplexer has additional flexibility in signal routing. See “Enhanced Routing” in Chapter 3 for more information.

DDM-2000 OC-12 Multiplexer

The DDM-2000 OC-12 Multiplexer is a SONET standard compliant OC-12 multiplexer. It multiplexes data coming into its low-speed ports and channels together to form the OC-12 high-speed optical signal. In the opposite direction, it demultiplexes data from its high-speed port to its low-speed ports. The high-speed optical interface and TSI of the DDM-2000 OC-12 Multiplexer operates at 622 Mb/s. It supports 12 DS3s, 12 EC-1s, 4 OC-3s, 4 OC-3cs, or a mixture of these (up to a capacity equivalent to 12 DS3s) in its low-speed ports.

OC-12 Regenerator

The OC-12 Regenerator extends the span length of the DDM-2000 OC-12 Multiplexer, making it well suited for interoffice applications. OC-12 Regenerators are supported in both balanced (equal numbers of regenerators on service and protection lines) and unbalanced (unequal numbers of regenerators on service and protection lines) modes. Diverse routing is supported in either mode, allowing one line to travel over a longer route than the other.

The OC-12 Regenerator offers streamlined operations and maintenance capabilities. These capabilities allow the regenerator to be deployed in remote sites as well as central offices. The OC-12 Regenerator has been classified discontinued availability (DA).

DDM-2000 FiberReach Multiplexer

The DDM-2000 FiberReach Multiplexer is the newest member of the DDM-2000 product family. The DDM-2000 FiberReach Multiplexer is a full-service access product, combining a 48-line optical network unit with a complete DS1 interface product. DDM-2000 FiberReach is a SONET product that is "hosted" by either a DDM-2000 OC-3 Multiplexer or a *SLC*®-2000 Access System. The extension from the host node is an OC-1 signal in a ring topology. See 363-206-300, *DDM-2000 FiberReach Applications, Planning, and Ordering Guide*, for more information.

Flexible Network Applications/Upgrades

The DDM-2000 Multiplexers form an efficient and highly flexible system, satisfying a wide variety of network applications in phased releases. DDM-2000 OC-3 and OC-12 Multiplexers are designed to satisfy the needs of loop-feeder, interoffice, and private network environments. They offer a range of capacities and network configurations, such as point-to-point, linear drop, hubbing, add/drop, and self-healing ring.

A DDM-2000 system is a powerful platform for network evolution. Capacity upgrades and network reconfigurability give the network planner the flexibility needed to optimize an initial deployment for near-term needs while leaving future options open. Any DDM-2000 Multiplexer OC-3 application can be expanded to an OC-12 capacity by adding the DDM-2000 OC-12 shelf to the OC-3 sites, or adding a 24G-U, 24H-U, 29G-U, or 29H-U OLIU to an OC-3 shelf. The initial investment in DDM-2000 OC-3 equipment and training is preserved through circuit pack reuse and unified operations features. Meanwhile, feature and network topology evolution is achieved by remote software downloads and occasional circuit pack changes.

Optics

DDM-2000 Multiplexers provide a variety of optical interfaces with a large range of span lengths, wavelengths, and expense. Technical details of these optical interfaces can be found in Section 11, "Technical Specifications."

OC-1 Optics

The DDM-2000 FiberReach Multiplexer supports an OC-1 long reach high-speed interface that is SONET compliant. The nominal OC-1 rate is 51.84 Mb/s.

OC-3 Optics

DDM-2000 OC-3 and OC-12 Multiplexers offer SONET compliant OC-3 long-reach optics and OC-3 intermediate- to long-reach optics. This interface operates at a 1310 nanometer (nm) wavelength.

IS-3 Optics

DDM-2000 OC-3 and OC-12 Multiplexers offer interconnect level 3 (IS-3) intraoffice short reach optics, which provide an option for interconnecting equipment at the OC-3 rate (155 Mb/s) in a central office or equipment room. These optics are particularly useful when interconnecting a DDM-2000 OC-12 Multiplexer shelf to a colocated DDM-2000 OC-3 Multiplexer shelf.

OC-12 Optics

The DDM-2000 OC-12 Multiplexer provides a 1310 nm optical interface which is fully compatible with SONET long-reach specifications. It also provides a 1550 nm interface. Either of these interfaces can be used in any application of the DDM-2000 OC-12 Multiplexer (point-to-point, hubbing or rings). For diverse routing applications, a DDM-2000 OC-12 Multiplexer shelf configured for service and protection can support both 1550 nm and 1310 nm operation, allowing one line to travel over a longer route than the other.

The DDM-2000 OC-3 Multiplexer also supports optional OC-12 1310 nm and 1550 nm optics for ring applications. The OC-12 interface can be used in any application supported by the OC-3 interface. The OC-3 shelf can drop up to 7 STS-1 equivalent traffic to low-speed OC-3/OC-1 interfaces from the OC-12 ring interface. In addition, the shelf can pass through up to 12 STS-1, four STS-3c channels or 336 VT1.5 channels.

Automatic Protection Switching

The protection switching features of the DDM-2000 OC-3 and OC-12 Multiplexers give a network added reliability by minimizing outages and service degradations. In the case of hard failure, like a fiber cut, a signal failure, or a signal degrade, which might be caused by an aging laser, the DDM-2000 OC-3 and OC-12 Multiplexers automatically switch traffic to a protection path. Switching can also be manually initiated as desired to simplify maintenance activity. DDM-2000 OC-3 and OC-12 Multiplexers use 1+1 protection of OC-N facilities when configured in point-to-point or hubbing topologies. DDM-2000 OC-3 and OC-12 Multiplexers provide VT1.5 and STS-1 level path protection switching, consistent with Telcordia Technologies TR-TSY-000496, to support OC-3 rings, STS-1 and STS-3c level path protection switching to support OC-12 ring topologies. In addition the DDM-2000 OC-3 Multiplexer supports VT1.5 to OC-1 protection switching to support DDM-2000 FiberReach OC-1 rings. Both DDM-2000's 1+1 and its path protection switching schemes initiate switching on hard failures as well as partial signal degradation. All transmission and timing circuit packs are 1x1 (non-revertive) protected except for the 1x7 (revertive) protection on DS1 circuit packs. The DDM-2000 OC-3 and OC-12 Multiplexers can also operate unprotected.

Dual-Homed Topologies

DDM-2000 OC-3 and OC-12 Multiplexers support the need of today's networks to provide high reliability service, even in the event of a catastrophic add/drop node failure, by providing dual-homed access topologies such as OC-1 on OC-3, and OC-3 on OC-12.

Dual Ring Interworking (DRI) Topologies

Both DDM-2000 OC-3 and DDM-2000 OC-12 Multiplexers provide a "drop-and-continue" feature necessary on DRI path switched rings to add/drop the same data at two separate ring nodes. By add/dropping these two identical data streams at physically separate locations, the network provider gains the ability to offer services that can survive protection not only from fiber and equipment failures but also from office failures, such as a fire.

Linear Optical Extensions from Rings

DDM-2000 OC-3 and OC-12 Multiplexers provide OC-3 1+1 protected or unprotected and 0x1 linear optical extensions from nodes on OC-3 or OC-12 rings. This topology is very useful in the access network environment for providing an OC-3 interface directly to an end user. The ring provides the reliability and the optical extension provides the privacy that the end user needs.

OC-1 Extensions to DDM-2000 OC-3, OC-12, and FiberReach

The power and flexibility of DDM-2000 OC-3, OC-12 and *SLC*®-2000 Access System networks are extended to small end user locations by the DDM-2000 FiberReach Multiplexer, a member of the DDM-2000 product family. The DDM-2000 FiberReach Multiplexer works with DDM-2000 OC-3 Multiplexers and *SLC*-2000 Access System in an exceptional variety of networking options, including OC-1 path switched ring extensions and fully survivable dual-homing topologies. The complete operations, administration, maintenance, and provisioning (OAM&P) capabilities of the DDM-2000 FiberReach Multiplexer satisfy the need for centralized operations and rapid response to user service demands. See 363-206-300, *DDM-2000 FiberReach Applications, Planning, and Ordering Guide*, for more information.

SONET Electrical Multiplexer

The DDM-2000 OC-3 Multiplexer is an extremely convenient and cost-effective "gateway" from an asynchronous network to the SONET network when configured as a SONET electrical multiplexer. In this configuration, the DDM-2000 OC-3 multiplexes DS1s into SONET standard EC-1 interfaces for interconnecting to other SONET equipment such as the DACS IV-2000 Digital Cross-Connect System, the FT-2000 OC-48 Lightwave System, and the *5ESS*® switch.

Time Slot Interchange

Complete bandwidth management features complement DDM-2000's flexible capacity and topology capabilities. STS-1 and VT1.5 TSI allow individual DS1 and DS3 services to be added, dropped, and groomed anywhere in the network. The grooming flexibility of TSI, not possible with time slot assignment (TSA), is especially useful in administering complex networks. For example, pass-through tributaries at a hub site may be groomed to shed unused bandwidth, thus increasing facility utilization and preserving spare capacity for unforeseen demand.

In the DDM-2000 OC-3 Multiplexer, TSI is provided by the optical line interface unit (OLIU) and operates on individual STS-1 and VT1.5 tributaries across the entire STS-3 bandwidth of both line and drop interfaces. The DDM-2000 OC-12 Multiplexer provides both an economical "cut-through" capability for fixed assignment between line and drop time slots as well as full STS-1 TSI across the entire STS-12 capacity.

Mixed Fiber and Radio Topologies

DDM-2000 OC-3 Multiplexer linear and ring topologies are used as part of the Lucent Technologies and *Harris-Farinon* MegaStar* 2000 Radio system supporting mixed fiber and radio topologies.

These configurations feature:

- Hybrid fiber and microwave architecture
- Data communications channel (DCC) connectivity across the microwave span
- Similar OAM&P as DDM-2000 OC-3 and OC-12 Multiplexer linear and ring networks.

OC-3 Ring Capacity Expansion

OC-12 OLIU circuit packs (24G-U, 24H-U, 29G-U, or 29H-U) are available to install into the OC-3 G3 or later shelf. This allows the OC-3 shelf to have the high-speed characteristics of an OC-12 shelf, with the low-speed inputs and capacity of an OC-3 shelf. This is accomplished by installing a pair of 24G-U, 24H-U, 29G-U, or 29H-U OLIU circuit packs into the MAIN slots of the OC-3 shelf and connecting the two OC-12 OLIUs with a faceplate cable.

This feature provides a lower cost solution in many OC-12 applications. Customers with existing OC-3 rings can increase the ring capacity from 84 DS1s (3DS3s) to 336 DS1s (12 DS3s). This in-service capacity upgrade requires replacing the OC-3 optics in the main slots with the 24G-U, 24H-U, 29G-U, or 29H-U OLIU at every node in the OC-3 ring. Once upgraded, each node receives all 12 STS-1s contained in the fiber and can select up to any 3 STS-1s (R13) or 7 STS-1s (R15) to drop. The remaining STS-1s are passed through the node and continue on the OC-12 ring.

An alternative application is to have the OC-3 shelf (with OC-12 optics) serve as a low capacity node in an OC-12 ring with existing OC-12 shelf nodes. This allows DS1 service and FiberReach connections from the OC-3 shelf directly out of an OC-12 ring. Also, when supporting the OC-12 optics, the OC-3 shelf can support STS-3c pass-through circuits as well as STS-1s. An OC-12 ring can consist of any combination of OC-12 and OC-3 shelves. This allows customers to install only the drop capacity needed at a given node. The OC-12 shelf nodes use OC-12 software and the OC-3 shelf nodes use OC-3 software which supports the 24G-U, 24H-U, 29G-U, or 29H-U OLIU circuit pack.

Data Service Delivery

Increasing demands for data and multimedia applications have led to a significant growth in local area network (LAN) service needs among business customers. To transport these LAN data services over the public network, LAN routers and concentrators collect the data at a LAN location and the BBF9/BBF10 LAN circuit pack maps it into traditional DS1 telephone network transmission signals. These DS1 telephony signals can then be transmitted over an Access/Transport Network another location where the data can be mapped onto the LAN circuit pack at that location. DDM-2000 OC-3 Multiplexers are ideally suited to serving the growing demands for such LAN services. The DS1s from the LAN circuit pack can be multiplexed into a DS3 by a transmultiplexer circuit pack and connected to an ATM edge switch for transmission over the ATM transport network or a facilities ring SONET network. Using such an external LAN/ATM switch approach, DDM-2000 OC-3 Multiplexers can provide the necessary transport and bandwidth management capabilities to meet the business customer LAN interconnect service needs. Delivering LAN interconnect services using DDM-2000 provides the same high level of reliability and availability for these services as is supported for all other premium business services. Beginning with Release 15.0, the low-speed slots of the DDM-2000 OC-3 shelf will support the LAN circuit pack to be used to interconnect a LAN through the IEEE standard 802.3 compliant interface.

Release 11.0 introduces a new DS3 Data Services Interface circuit pack (BBG19) for use with data edge devices. Up to four BBG19s can be installed in the DDM-2000 function units connecting data edge devices with services such as Ethernet, Token Ring, ATM, FDDI, Frame Relay, and others to the SONET access ring.

High Quality Network Synchronization and Timing

DDM-2000 OC-3 and OC-12 Multiplexers can be configured to take advantage of the highest quality timing reference available in a given network synchronization environment. They can free run from their internal oscillator, either 20 ppm or stratum 3 stability; they can loop-time from the incoming signal on a high-speed interface; or they can obtain timing from an external source via DS1 timing references.

DDM-2000 OC-3 and OC-12 Multiplexers provide a synchronization messaging feature to ensure the integrity of network synchronization during both normal and abnormal conditions. Through the use of synchronization messaging, the current quality of the timing source can be conveyed from one DDM-2000 Multiplexer to another. This capability allows the DDM-2000 OC-3 and OC-12 Multiplexers to automatically change their timing reference in order to always maintain the highest quality timing available. The capability also allows the DDM-2000 OC-3 and OC-12 Multiplexers to inform a local building integrated timing supply (BITS) clock when the DS1 timing output has been degraded and should no longer be used as a reference. The synchronization messaging feature is based on the scheme developed in the *ANSI* * T1X1 standards committee.

Performance Monitoring for Proactive Maintenance and Tariff Verification

Performance monitoring (PM) is necessary for proactive maintenance procedures that correct network problems before they become service affecting. The DDM-2000 Multiplexers offer full performance monitoring and reporting of SONET section, line, path, DS1, and DS3 parameters. Thresholds for each parameter can be provisioned on a per-shelf basis to satisfy specific installation requirements.

The DDM-2000 OC-3 Multiplexer takes advantage of the embedded PM capabilities found in end-user DS1 service termination equipment to provide complete end-to-end PM of DS1 and DS3 tariffed service offerings.

This allows service providers to verify that the error performance experienced by an end customer is operating within the contractually guaranteed limits of their specific service tariff. Since this capability is directly integrated into the DDM-2000 Multiplexer, the service provider can eliminate the cost and extra operations complexities associated with external monitoring equipment.

* Registered trademark of American National Standards Institute.

On-Board Power Modules

The DDM-2000 OC-3 and OC-12 Multiplexers eliminate the need for external power circuit packs by providing on-board power modules to convert central office voltages. This distributed power configuration allows for a more uniform heat dissipation, aids in keeping system first-costs low, and minimizes overall shelf size.

Low Power

The DDM-2000 OC-3 and OC-12 Multiplexers meet strict power dissipation requirements for maximum utilization of capacity in bay arrangements. Six DDM-2000 OC-3 Multiplexers (18 DS3 equivalents) or three DDM-2000 OC-12 Multiplexers (36 DS3 equivalents) housed in a 7-foot bay meet Telcordia Technologies network equipment building system (NEBS) power density requirements. The DDM-2000 Multiplexers are also designed to interwork with other Lucent Technologies transmission equipment to meet power requirements of cabinet applications.

Flexible and Economic System Size

Through extensive use of very large scale integration and high-density packaging, the DDM-2000 OC-3 Multiplexer and the DDM-2000 OC-12 Multiplexer provide up to 3 DS3 (84 DS1s) equivalents in a single 8.5-inch shelf and 12 DS3 equivalents in a single 14-inch shelf, respectively. The compact size of the DDM-2000 OC-3 and OC-12 Multiplexers allows for flexible and economical arrangements in a variety of enclosures. A 7-foot bay can hold up to 6 DDM-2000 OC-3 shelves for a total capacity of 18 DS3/STS-1 signals or 3 DDM-2000 OC-12 shelves for a total capacity of 36 DS3/STS-1 signals. A typical 7-foot bay configuration can support a single DDM-2000 OC-12 shelf and up to 4 DDM-2000 OC-3 shelves that can terminate the OC-12 lines into 336 DS1s.

A highly modular architecture allows for economical low-density applications as well. Multiplexer groups can be equipped independently, as growth occurs, minimizing the initial system start-up cost.

Suitable for Any Environment

The DDM-2000 OC-3 and OC-12 Multiplexers operate in the environmentally uncontrolled outside plant as well as in standard central office environments. They also meet electromagnetic compatibility (EMC) and UL requirements for all applications, including customer premises. The DDM-2000 OC-3 and OC-12 Multiplexers also have Canadian Standards Association (CSA) Certification Standard C22.2 No.225-M90.

Convenient Cabling Access

Front and rear access cabling options are available on DDM-2000 OC-3 and OC-12 Multiplexers. The front access option, typically required in outside plant cabinet installations, is achieved by using dangler (cables that come from the rear of the cabinet over the top to allow front access to rear connectors) cables to reduce space requirements.

Universal Optical Connector

The DDM-2000 OC-3 and OC-12 Multiplexers provide Lucent's universal optical connector on all OLIUs. The universal optical connectors are receptacles on the faceplate of the OLIUs that allow a single OLIU to support either *ST*®, FC-PC, or SC connectors as needed. Both 0 dB and attenuating buildouts are supported.

Multiple Mounting Arrangements and Enclosures

The DDM-2000 OC-3 and OC-12 Multiplexers can be installed in any enclosure providing a standard 23-inch rack, such as a controlled environment vault (CEV), a hut, a customer location cabinet, a dedicated equipment room, a central office bay frame, or an outside plant cabinet. In the outside plant, this includes Lucent's 51A, 80A, 80D, and 80E cabinets. Indoors, it includes Lucent's 90A and 90B equipment cabinets.

SLC® Carrier Protection Switching

The DDM-2000 OC-3 Multiplexer allows the standard *SLC* 96 carrier system protection scheme to work through the fiber transports provided by the DDM-2000 terminals without the use of subscriber loop interface module (SLIM) terminals. The DDM-2000 OC-3 Multiplexer accomplishes this by translating an incoming DS1 bipolar violation alarm into an outgoing DS1 loss of signal (LOS). A downstream *SLC* 96 carrier system will detect this LOS and initiate protection switching of the DS1.

Three-Tiered Operations*

The DDM-2000 Multiplexer operations procedures are built on three levels of system information and control, spanning a user's operations needs from summary-level status to detailed reporting.

User Panel and Faceplate LEDs (Operations Tier 1)

The first operations tier consists of the user panel displays, pushbuttons, and the circuit pack faceplate light-emitting diodes (LEDs). The first tier allows routine installation and maintenance activities to be performed without a craft interface terminal (CIT) or any test equipment. The circuit pack faceplate FAULT LEDs allow fast and easy fault isolation to a particular circuit pack. The user panel provides system-level alarm and status information for both the local and remote terminals.

Craft Interface Terminal (Operations Tier 2)

The second operations tier provides access to DDM-2000 operations from a CIT over an EIA-232-D interface. System details that cannot be obtained from the first operations tier alone can be obtained over the CIT interface. A VT-100 compatible terminal or terminal emulator software running on a PC can be used as a CIT. Command and prompt modes are available with extensive on-line help features. The CIT interface supports OAM&P activities such as PM on any and all DDM-2000 NEs in the SONET maintenance subnetwork from a single DDM-2000. An optional software tool (CPro-2000) used with a PC is also available.

— CPro-2000 is a Windows-based application that provides access to Lucent's SONET NEs with a command-based AUI (ASCII user interface) and a GUI (graphical user interface). Using this tool, a user can take advantage of the graphics to do many provisioning related activities.

Operations System (OS) Interfaces (Operations Tier 3)

The third operations tier provides access to DDM-2000 Multiplexer operations from a remote operations system (OS). The DDM-2000 OC-3 and OC-12 Multiplexers offer parallel telemetry, telemetry byte-oriented serial (TBOS), and TL1/X.25 OS interfaces. These interfaces provide support for automated service provisioning, remote recovery and control, installation provisioning, alarm status,

* The introduction of Target ID Address Resolution Protocol (TARP) for Operations Interworking (OI) in DDM-2000 OC-3 Release 13.0 and 15.0 and OC-12 Release 7.0 will affect the operations of some features in the three tiers. Refer to Section 5, “Operations, Administration, Maintenance, and Provisioning,” for more information.

fault isolation, and fault location. An optional element management system (ITM SNC) is also available.

— Lucent's Integrated Transport Management SubNetwork Controller (ITM SNC) is an element management system (EMS) that supports SONET NEs. ITM SNC provides fault, provisioning, configuration, and security management functions via a GUI.

Lucent's DDM-2000 OC-3 and OC-12 Multiplexers offer a wide range of OS interfaces to meet the needs of an evolving OS network. Installations can optionally use TBOS protocol, office alarms interfaces, and optional parallel telemetry. In loop feeder applications, the DDM-2000 OC-3 and OC-12 Multiplexers transmit up to 21—depending on the release and OS type—user-definable environmental input points to the OS: 9 parallel, 15 TBOS, 21 TL1. These miscellaneous discrete points can be used to monitor co-located equipment at a remote site. In addition, four miscellaneous control points are available to control external functions (for example, generators or pumps).

A TL1/X.25 message-based OS interface is also provided to support the evolving OS network. This interface uses the standard X.25 protocol and can be connected to any X.25 packet network. It is compatible with Telcordia Technologies Network Monitoring and Analysis (NMA) System, Telcordia Technologies OPS/INE, Lucent ITM SNC, or a user at a terminal. This interface provides support for automated service provisioning, remote recovery and control, installation provisioning, alarm status, fault isolation, and fault location.

Lucent Product Family 2000 OI

Note: The term single-ended operations (SEO) has traditionally been used to refer to such operations among DDM-2000 systems. Now that SEO is supported among the 2000 Product Family NEs as well as multi-vendor operations, the term operations interworking (OI) is more commonly used.

The OI capability of the DDM-2000 Multiplexers provides remote access to all DDM-2000 systems in a subnetwork from a single location. This allows most maintenance, provisioning, and administration to be performed on a centralized basis, minimizing technician travel. CITs, user panel functions, and OS interfaces all give access to remote systems. Upgrades are simplified because OI is integrated into the DDM-2000 Multiplexers through the SONET section DCC. If desired, the DCC can be disabled between any two DDM-2000 shelves to create maintenance boundaries.

The FT-2000 OC-48 Lightwave System OI has been expanded to include DDM-2000 Multiplexers. This means that in subnetworks consisting of both DDM-2000 Multiplexers, and FT-2000 OC-48 R6.0 and later Lightwave System shelves, DDM-2000 Multiplexer alarms appear in FT-2000 OC-48 Lightwave System alarm reports, and FT-2000 OC-48 Lightwave System alarms are included

in DDM-2000 alarm reports. In addition, users at FT-2000 OC-48 Lightwave System shelves are able to log into any DDM-2000 shelf in the subnetwork using the FT-2000 OC-48 Lightwave System CIT. The FT-2000 OC-48 Lightwave System connectivity reports also list the DDM-2000 shelves in the subnetwork and vice-versa. This is in keeping with the Lucent 2000 Product Family philosophy of OI.

Multi-Vendor OI

To support multi-vendor OI, DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 support Target ID Address Resolution Protocol (TARP) instead of Lucent Directory Service (LDS). DDM-2000 FiberReach R3.0 and 3.1 and FT-2000 OC-48 R9.0 also support TARP, thus Lucent 2000 Product Family OI compatibility is still supported. However, there is no OI compatibility with previous LDS releases of DDM-2000 and FT-2000. TARP is the established multi-vendor standard for SONET NEs that support TL1 OS interfaces.

DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0, and FiberReach R3.0, 3.1, and 4.0 are developed to be compatible with any other-vendor NEs that also support TARP, OSI, OSI LAN, and TL1/X.25 as specified in Telcordia Technologies GR-253. In addition, DDM-2000's TARP Manual Adjacency feature enables DDM-2000 to operate in networks that include CMISE-based NEs which may not support TARP propagation.

DDM-2000's compatibility with Tellabs *TITAN* * 5500/S R5.0 DCS, including TL1/X.25 OS access, has been confirmed through cooperative joint testing. DDM-2000's compatibility with some other-vendor NEs has also been tested by independent third-parties such as Telcordia Technologies.

Because DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 are intended to facilitate OS-based centralized operations, and because TL1/X.25 OS access is the key standardized multi-vendor OI application, the following Remote NE Status features are **not** supported in DDM-2000 OC-3 R13.0 and OC-12 R7.0:

- Remote office alarms
- Remote CIT alarm reports
- Remote user panel indications
- TBOS
- Parallel telemetry.

Some of the Remote NE Status features have been restored in DDM-2000 OC-3 R15.0:

- Remote user panel status indications
- TBOS
- Parallel telemetry.

* *TITAN* is a trademark of Tellabs, Inc.

All of the above features depend on the proprietary exchange of information among Lucent NEs in a subnetwork, specifically the communication of each remote NE's alarm status to other NEs. Although the Remote NE Status features were supported in previous releases of DDM-2000, such Lucent-only operations features in multi-vendor subnetworks would not include other-vendor NEs, due to the lack of applicable standards, and thus would be incomplete.

Easy Installation

The DDM-2000 OC-3 and OC-12 Multiplexers minimize time and trouble with their simplified installation procedures. DDM-2000 OC-3 and OC-12 Multiplexers offer intelligent provisioning defaults for those parameters which are typically constant across many installations (for example, optical line switching threshold). Customer needs are carefully considered in determining these defaults to simplify system installation. If the provisioning parameters (for example, PM thresholds, alarm levels, etc.) need to be altered to meet a specific need, they can be easily changed using the CIT. The DDM-2000 OC-3 and OC-12 Multiplexers offer switch selectable settings for those parameters which often vary between installations (for example, DS1 line buildouts).

The DDM-2000 database backup and restoral capability of CPro-2000 can be used to significantly simplify the installation of several shelves having similar or identical configurations. After manually provisioning the first node, a backup is done to copy the configuration. This copy is then used to quickly and easily configure all of the remaining nodes using the restoral feature. Using CPro-2000 database backup and restoral in this fashion provides a much quicker and less error-prone installation than manual provisioning. It is particularly efficient in the case of complex topologies, such as add/drop or ring, which have a large amount of VT1.5 and/or STS-1 cross-connection provisioning.

The DDM-2000 OC-3 and OC-12 Multiplexers also offer integrated test capabilities that eliminate the need for external test equipment. These tests check all equipment involved with an installation: the DSX wiring, the optical facility, and the DDM-2000 OC-3 or OC-12 Multiplexer itself.

Remote Software Download and Copy

System software can be downloaded using a PC through the EIA-232-D interface on the user panel into the local system or to another system connected to the local system via the SONET DCC. The PC can also download the system software from a remote location as long as access to the target system is available via a data network, either directly to the EIA-232-D interface of the target system, or to that of any other system connected to the target system via the SONET DCC. In addition, system software can be copied between like systems connected by the SONET DCC. The remote software download and copy capabilities enable the network service providers to avoid costly craft dispatches for software upgrade.

The DDM-2000 OC-3 and OC-12 systems accept downloads without disrupting transmission and with minimal impact on operation functions. This enables the software upgrades to be transparent to the transmission services and to the network operations. The data compression techniques used in the system software download and copy reduce the total time the technicians spend on network upgrades.

Earlier software releases may be remotely downloaded, but an intermediate release may have to be loaded before going to the desired release.

Software Upgrades

Starting with DDM-2000 OC-3 Release 9.1 and OC-12 Release 5.1, the DDM-2000 OC-3 and OC-12 Multiplexers can upgrade the system software while in-service. DDM-2000 OC-3 and OC-12 Multiplexers use flash erasable programmable read-only memory (flash EPROM) chips to store the system software. Upgrades are distributed on *MS-DOS* * formatted diskettes containing the new software and an installation program. An enhanced software download feature allows the source NE to download compressed copies of the new generic to all other nodes in the network. This download software will remain inactive until the **apply** command is issued to overwrite the current software. This feature allows wide flexibility in scheduling upgrades throughout the network. These software upgrades are the primary mechanism to add new feature enhancements to the in-service DDM-2000 network.

The **ins-prog** command supports software installation from a personal computer (PC) and the **cpy-prog** command supports software installation from one shelf to another shelf.

* Registered trademark of Microsoft Corporation.

DDM-2000 Database Backup and Restoral

The DDM-2000 OC-3 and OC-12 Multiplexer databases can be backed up and restored from a file using CPro-2000 to protect valuable system information from loss due to a catastrophic failure. Catastrophic failures include:

- Shelf destruction by fire, hurricane, flood, or other natural event or intentional damage
- Cabinet housing the shelf damaged by a vehicle
- Manual errors during provisioning or maintenance.

The backup can be done using CPro-2000 through the CIT port of any one of the DDM-2000's to all DDM-2000's in the maintenance subnetwork. The information that can be backed up and restored includes:

- Target identifier (TID)
- Software version
- System equipage
- Software readable hardware switch settings
- CIT provisionable parameters (controller circuit pack data and transmission circuit pack data with cross-connect map).

The database backup and restoral capability of CPro-2000 can be used to significantly simplify the installation of several shelves having similar or identical configurations as described previously. See the following C-Pro-2000 manuals for further information:

190-523-101, *CPro-2000 User Manual,* Release 3.0
365-576-100, *CPro-2000 User Manual,* Release 4.0
365-576-110, *CPro-2000 User Manual,* Release 5.0
365-576-120, *CPro-2000 User Manual,* Release 6.0
365-576-130, *CPro-2000 User Manual,* Release 7.0
365-576-140, *CPro-2000 User Manual,* Release 8.0
365-576-150, *CPro-2000 User Manual,* Release 9.0
365-576-160, *CPro-2000 User Manual,* Release 10.0

Remote Inventorying Capabilities

The DDM-2000 OC-3 and OC-12 Multiplexers provide automatic version recognition of all hardware and software installed in the system. All circuit pack *CLEI* [*] codes and serial numbers are accessible by the system controller. This greatly simplifies inventorying, provides recognition of the current version of hardware and software being used, and allows easy identification of circuit packs by their manufacturing date.

Security

The DDM-2000 OC-3 and OC-12 Multiplexers offer security against unauthorized access via its CIT port or through a remote operations port. The use of security is provisionable for the front CIT port, the rear CIT (modem) port, and through the DCC. In addition to this, the DCC can be totally disabled to ensure isolation of a DDM-2000 system from possible remote intrusion. A provisionable timeout is available for each access port that enables automatic termination of inactive or unattended sessions.

The DDM-2000 Multiplexers support four user levels:

- privileged, with full read/write access to all information on the system, including passwords
- general, with read/write access to system provisioning and maintenance information
- maintenance, with read/write access to limited maintenance related system provisioning and maintenance information
- reports-only, with read access to system information but no ability to modify provisioning and maintenance parameters.

Each user has an individual login and password, and each user selects and maintains his/her own password. Lockout of nonprivileged users and log of all login attempts during lockout are provided.

* COMMON LANGUAGE is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Bell Communications Research, Inc.

Standards Compliance

The DDM-2000 OC-3 and OC-12 Multiplexers comply with *ANSI* and Telcordia Technologies standards on SONET, asynchronous interface standards, and technical advisories/technical requirements (GRs) on OAM&P. Environmental standards include Telcordia Technologies NEBS requirements, FCC EMC requirements, and *UL* 1459.

The DDM-2000 OC-3 and OC-12 Multiplexers also have Canadian Standards Association (CSA) Certification Standard C22.2 No.225-M90.

The 2000 Product Family Advantage

Lucent's 2000 Product Family is unique in the industry by providing a full-range product line. The *SLC*-2000 Access System, DDM-2000 Multiplexers, FT-2000 OC-48 Lightwave System, and DACS III/IV-2000 Cross-Connect Systems offer complete feature coverage, working together to build a coordinated network solution for present and future services. Capacity and configuration can be optimized for each situation, knowing that the future network can evolve through the modular flexibility of the 2000 Product Family.

FT-2000 OC-48 Release 6.0 and later Lightwave System offers features to complement the DDM-2000 product family and to provide OI. This means customers can deploy these 2000 Product Family systems in a single subnetwork resulting in increased profitability. See Section 5, "Operations, Administration, Maintenance, and Provisioning," for more information on OI with Lucent's 2000 Product Family.

Common modules and circuit packs simplify maintenance and provisioning and reduce inventory costs. Coordinated operations features and a consistent "look-and-feel" mean that technicians will be quicker and more accurate at their daily OAM&P tasks. And Lucent's 2000 Product Family will continue to offer these benefits with a coordinated product evolution strategy to support a changing network.

The *SLC*-2000 Access System, part of Lucent's 2000 Product Family, integrates the DDM-2000 OC-3 Multiplexer hardware and software. Most of the features offered by the DDM-2000 systems are also offered in the *SLC*-2000 systems, providing flexible access solutions. See 363-208-000, *SLC-2000 Access System Applications Planning and Ordering Guide*, and 363-206-300, *DDM-2000 FiberReach Applications, Planning, and Ordering Guide*, for more information.

Easy to Order

The DDM-2000 OC-3 and OC-12 Multiplexers' ordering is simplified through planning tools, technical support services, common equipment, and ample inventories. Standard configuration 51A, 80-type (remote cabinet), and 90-type Business Remote Terminal (customer location cabinet) packages including DDM-2000, DDM-2000 FiberReach, *SLC* series 5 carrier system, and DDM-Plus are available to simplify system ordering and planning. Typical bay arrangements for the DDM-2000 Multiplexers are also available.

Applications

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Applications

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Overview

The DDM-2000 Multiplexers serve a wide range of service applications in a wide variety of network configurations economically and efficiently. The first part of this section, "Network Configurations," describes some of the network configurations in which the DDM-2000 Multiplexers and related products can be used to provide specific service applications. The second part of this section, "Service Applications," describes some of the many service applications that can be served with DDM-2000 Multiplexers.

Because the DDM-2000 Multiplexers are very flexible, most of the service applications described in the second part of this section can be served with many of the network configurations described in the first part. The particular network configuration used for a particular service application depends on many factors such as the physical locations involved, cost, mix of multiple services to be provided with a single network, required interconnections to other networks, and others.

Introduction

DDM-2000 Multiplexers provide the flexibility required for operation in today's changing telecommunications networks. With topology and capacity upgrades, a DDM-2000 network can be installed with minimum first cost and then easily grown to add new sites and new services. Many DDM-2000 circuit packs are common with other Lucent Technologies 2000 Product Family products, resulting in further savings as the network evolves.

The DDM-2000 OC-3 and OC-12 Multiplexers are also an ideal solution for private network and customer location applications. The DDM-2000 OC-3 and OC-12 Multiplexers comply with electromagnetic compatibility (EMC) requirements per FCC Title 47, Part 15, and safety requirements per *UL* 1459 for equipment in dedicated equipment rooms. The DDM-2000 Multiplexers also have Canadian Standards Association (CSA) Certification Standard C22.2 No. 225-M90. Standard access node configurations are available in Lucent's 51A, 80-type and 90-type BRT-2000 cabinets. Fiber distribution of DS1 services is supported with the DDM-Plus extension shelf or DDM-2000 FiberReach, which allows mixing of DS1 line repeater interfaces for embedded metallic facilities and protected quad DS1 optical interfaces. DS0 and Integrated Services Digital Network (ISDN) services are supported from the *SLC*®-2000 Access System through copper and fiber distribution.

The DDM-2000 FiberReach Multiplexer is the newest member of the DDM-2000 product family and can be used in all DDM-Plus applications where increased capacity and integrated operations, maintenance, and provisioning features are needed. Only representative DDM-2000 FiberReach Multiplexer applications are included in this section. For more application information, see 363-206-300, *DDM-2000 FiberReach Applications, Planning, and Ordering Guide*.

Network Configurations

This part describes many of the network configurations in which the DDM-2000 Multiplexers can be used. In addition to the configurations specifically described, many other combinations of these network configurations can be used to meet specific application needs.

To clarify interface terminology, the terms **single 0x1** and **dual 0x1** have been replaced with the term **ring (0x1) low-speed interface(s)** or simply (0x1). The terms single and dual are used in describing homing topologies. The term **1+1** has been replaced by the term **linear (1+1) low-speed interface(s)** or simply (1+1). To clarify timing terminology, the term **loop timing** is a special case of **line timing**. See the "Glossary" for definitions of these terms.

Path Switched Rings

The need to prevent service outage caused by network failure has created a new class of applications. The 2000 Product Family offers a wide range of self-healing network features that automatically protect against service outage caused by cable cuts and equipment failures, which in turn protect customers and generate increased revenue. These self-healing features include flexible DACS-based restoration with the *DACScan*® controller, FT-2000 OC-48 Lightwave System two- and 4-fiber rings, DDM-2000 OC-3 and OC-12 virtual tributary 1.5 (VT1.5) and STS-1 path switched rings, and *SLC*-2000 Access System path switched rings.

DDM-2000 OC-3, *SLC*-2000 Access System, and DDM-2000 OC-12 self-healing rings offer the performance and administrative benefits demonstrated by the successful Lucent FT Series G Ring Diversity Switch. Since the DDM-2000 OC-3 and OC-12 path switched rings operate in an integrated, single-ended fashion, complex network-level coordination is not necessary to restore traffic. This means restoration is faster and more reliable. Furthermore, bandwidth administration and network reconfigurations (for example, adding or deleting nodes) can be easier because path switching does not require special time slot assignment rules.

A network which requires the bulk of its traffic to be dropped at a single node is an ideal application for path switched rings. A typical loop feeder network, where most traffic is between the subscriber loop to a central office, fits this mold. Such an application calls for the delivery of protected DS1 and DS3 service to customer locations. In many cases, where the network serves only voice traffic and DS1s, a DDM-2000 OC-3/*SLC*-2000 path switched ring is a perfect fit. If DS3 service or a mixture of DS1 and DS3 service is needed, multiple OC-3 rings or an OC-12 ring may be necessary. Cost, fiber availability, and bandwidth flexibility all play a part in determining whether a single OC-3 ring, multiple OC-3 rings, or an OC-12 ring will be the best network solution.

The DDM-2000 OC-3 and OC-12 VT1.5 or STS-1 path switched rings operate as shown in Figure 3-1(a.). Traffic entering a path switched ring node is sent onto both rotations of the ring. At the receiving node, the signal having the highest integrity (based on SONET path information) is selected and dropped as outgoing traffic. At intermediate nodes, the traffic is "passed-through" without changing the SONET path information. The DDM-2000 OC-3/OC-12's VT1.5/STS-1 Time Slot Interchange (TSI) capabilities make the provisioning of add/drop and pass-through traffic quick and easy.

The self-healing nature of the path switched ring is shown in Figure 3-1(b.). In this case, the fiber failure between nodes C and D causes node C to switch from the counterclockwise ring to the clockwise ring, thus maintaining service between node A and C.

In addition, the backup and restoral capability of CPro-2000 can be used to significantly reduce the effort and increase the accuracy of installing several complex ring shelves having similar or identical configurations. After manually provisioning the first node, CPro-2000 can be used to make a copy of the configuration. This copy can then be used to quickly and easily configure all of the remaining nodes using the restoral feature of CPro-2000. Using system backup and restoral in this fashion provides a much quicker and less error-prone installation than manual provisioning.

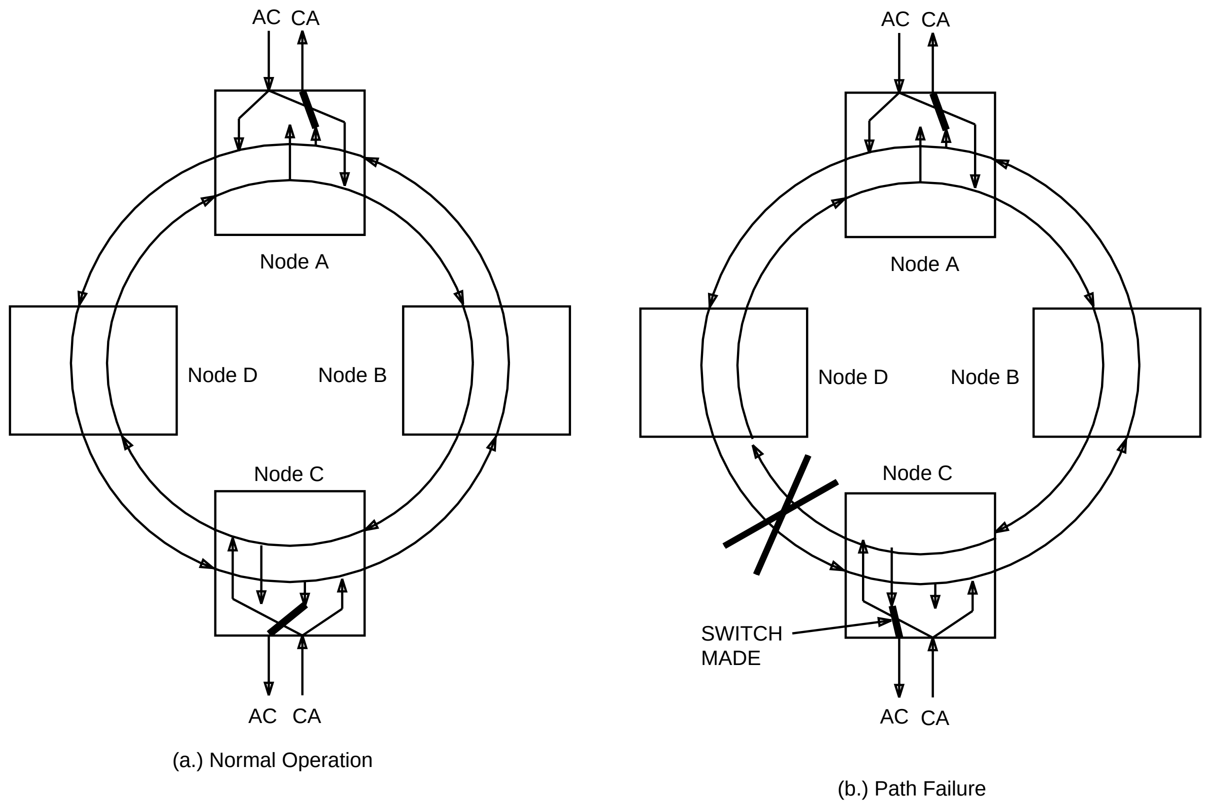

Figure 3-1. Path Switched Ring

OC-3 Path Switched Ring

The OC-3 path switched ring allows several remote sites to share the two-fiber ring facility back to the CO (Figure 3-2). The DDM-2000 OC-3 Multiplexer interfaces to the ring through the Main slots at the OC-3 rate and uses its programmable VT1.5/STS-1 TSI capability. Path switching can be done on VT1.5 paths, STS-1 paths, or a mixture of these. Up to 84 DS1s, 3 DS3s, 3 EC-1s, or equivalent combination can be added/dropped from the DDM-2000 OC-3 Multiplexer path switched ring at any node. Because of the ring's path protection scheme, time slots must be reserved all the way around the ring for all ring traffic, limiting the capacity of the ring to the OC-3 line rate. Like the DDM-2000 OC-3 add/drop topology, the TSI feature offers full flexibility in assigning signals between low-speed DS1, DS3, EC-1, or T1 ports, and the high-speed interface at each node. The DDM-2000 OC-3 Multiplexer can easily adapt to unpredicted growth at a ring node.

Extensive equipment reuse between DDM-2000 OC-3 terminal, add/drop, and ring nodes offers a significant operational advantage. The DDM-2000 OC-3 Multiplexer ring shelf is the same shelf as used in terminal and add/drop applications. Also, circuit packs can be retained when upgrading a linear network to a ring.

The ring topology routes traffic between a CO site and a set of RT sites, as in the add/drop topology, while providing complete protection. In addition, only two OLIUs are needed per DDM-2000 OC-3 Multiplexer, which provides a cost savings over the add/drop topology. Traffic can also be routed between RT sites. The ring can start with as few as two nodes and grow to support many nodes through in-service node additions.

For protection against a CO failure, it may be desirable to include a second CO node in the ring. This dual homing architecture allows all services to be routed to the alternate CO while the first CO is out of service.

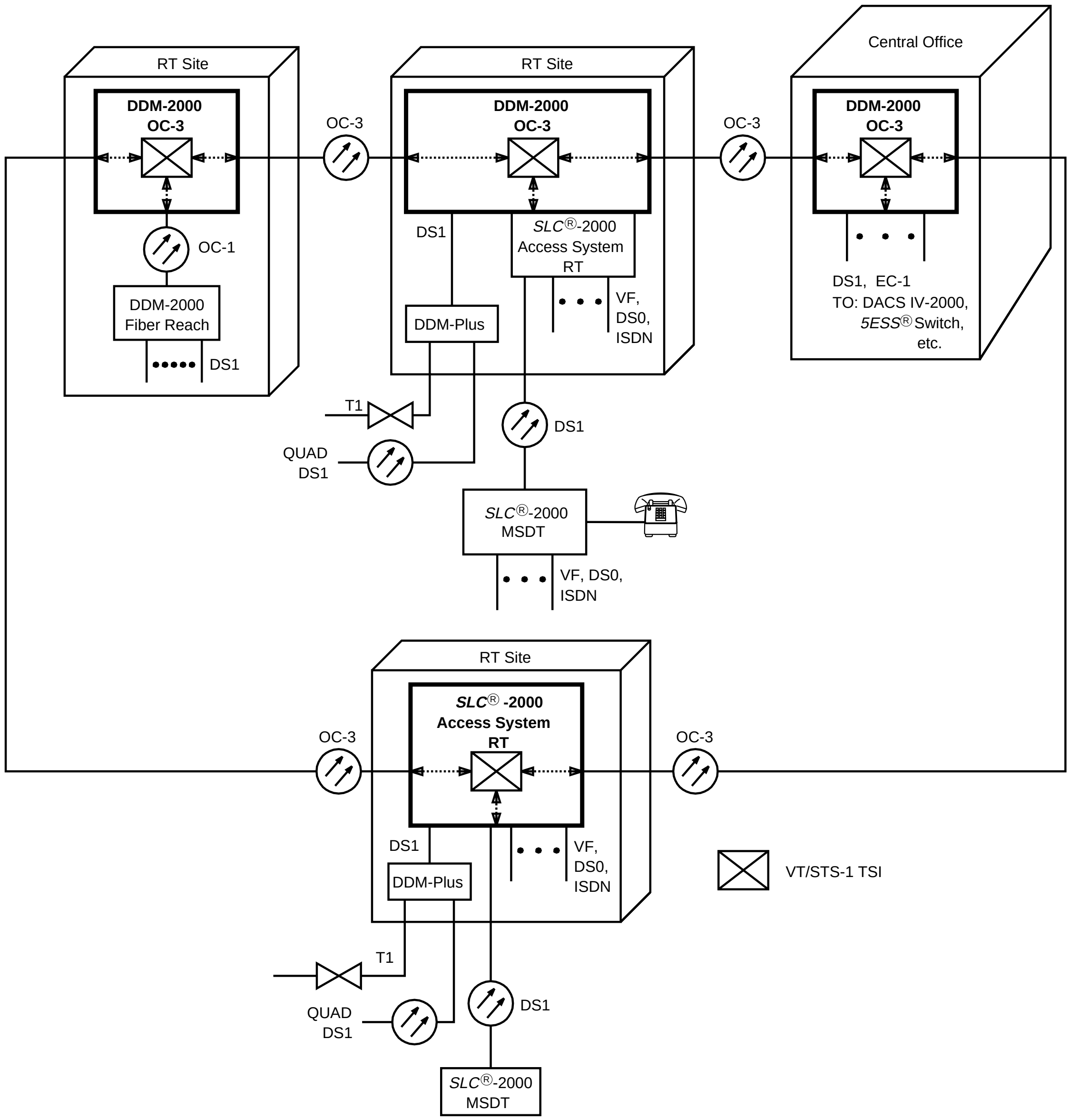

Figure 3-2. OC-3 Path Switched Ring

A DDM-2000 OC-3 Multiplexer VT1.5/STS-1 path switched ring is a very effective self-healing network topology for small cross-section interoffice networks such as outstate trunks. Low-density routes that primarily transport DS1 traffic are ideally suited to the DDM-2000 OC-3 Multiplexer path switched ring. DS3s/EC-1s may also be carried between offices on DDM-2000 OC-3 Multiplexers (Figure 3-3).

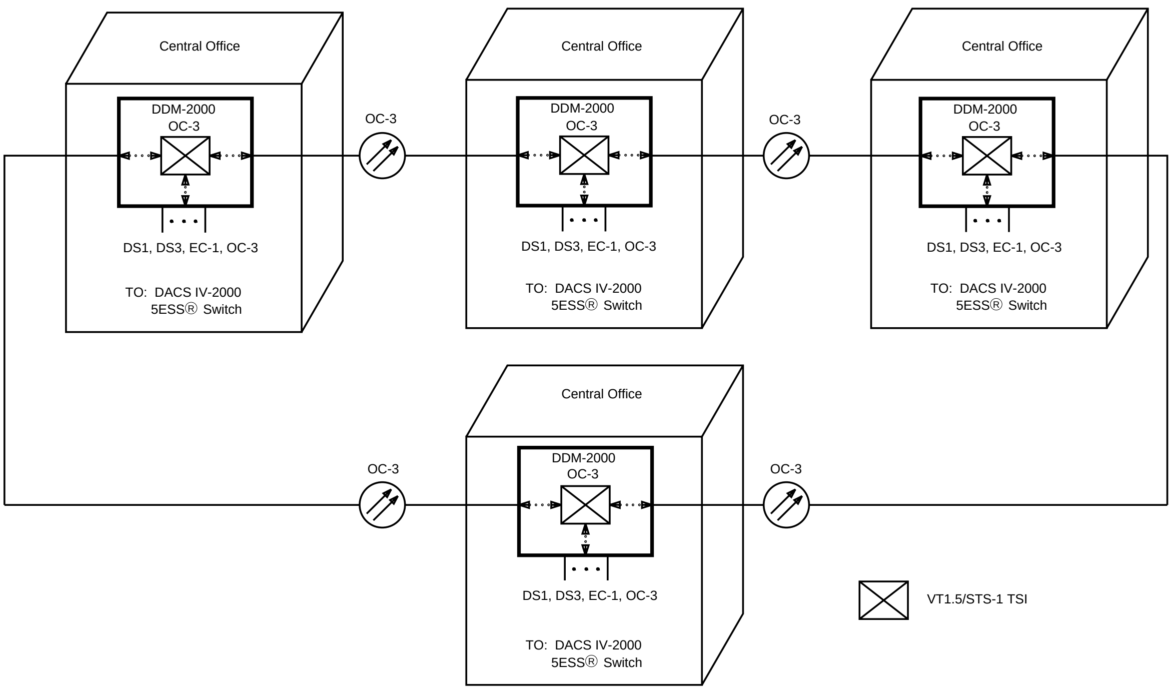

Figure 3-3. DDM-2000 OC-3 Path Switched Interoffice Ring

Alternatively, a DDM-2000 FiberReach can be equipped with OC-3 optics. This option offers a cost effective solution at locations where the dropped traffic is primarily VT1.5 based and is accessed from any one of the 3 STS-1s. DDM-2000 OC-3 multiplexers can be mixed in the same OC-3 ring. The OC-3 multiplexers can be used at sites requiring DS3 and other higher bandwidth STS path-switched traffic, while the FiberReach multiplexer is used at sites requiring VT path access for DS1, T1, etc. Figure 3-4 shows an OC-3 ring that includes both OC-3 and FiberReach multiplexers.

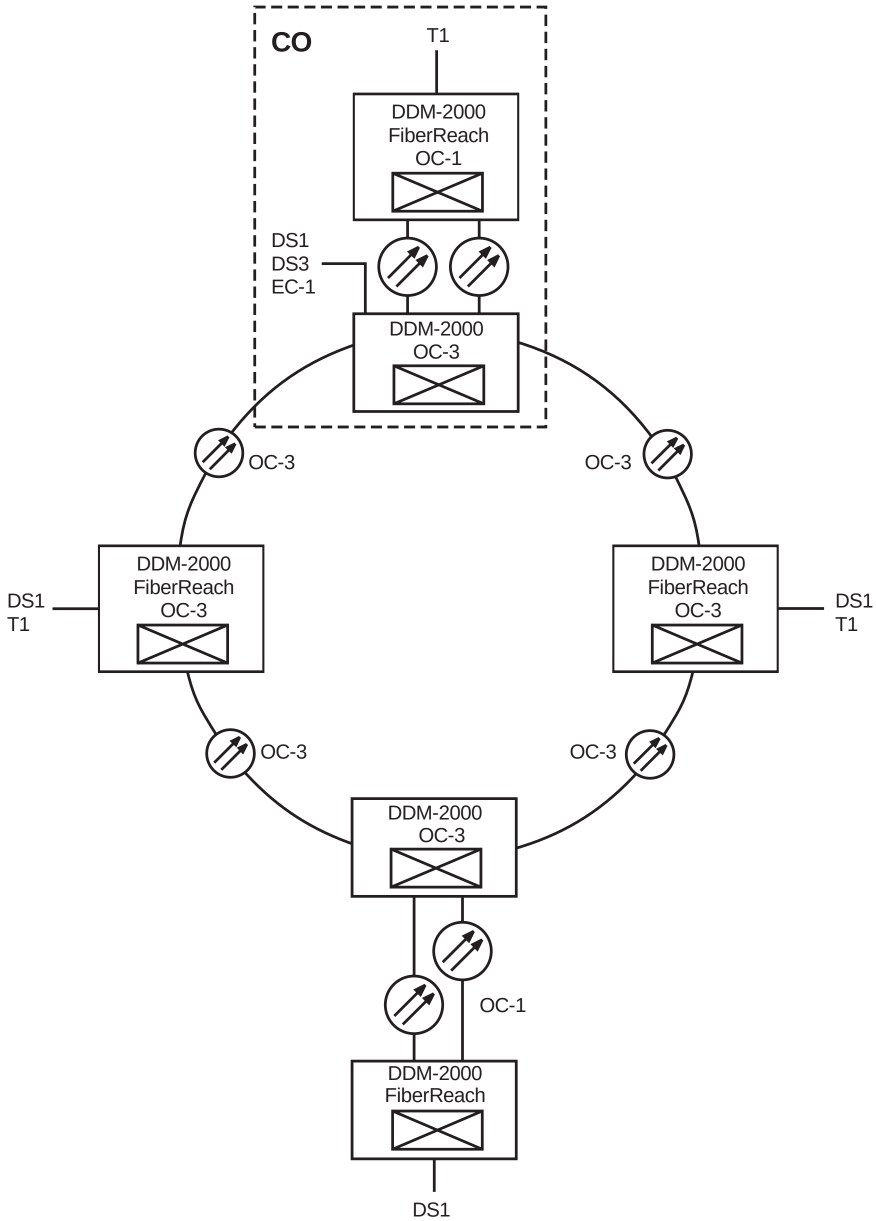

Figure 3-4. OC-3 Path Switched Ring Using OC-3 Multiplexer and FiberReach Multiplexer With OC-3 Optics

OC-12 Path Switched Rings

The DDM-2000 OC-12 Multiplexer provides STS-1/STS-3c level path protection switched ring capability. As shown in Figure 3-5, it provides transport of 12 DS3s, 12 EC-1s, 4 OC-3cs, or a mixture with path switching at the STS-1 level (STS-3c level for OC-3c traffic). Such a ring provides an economical, flexible, and reliable solution for loop feeder networks.

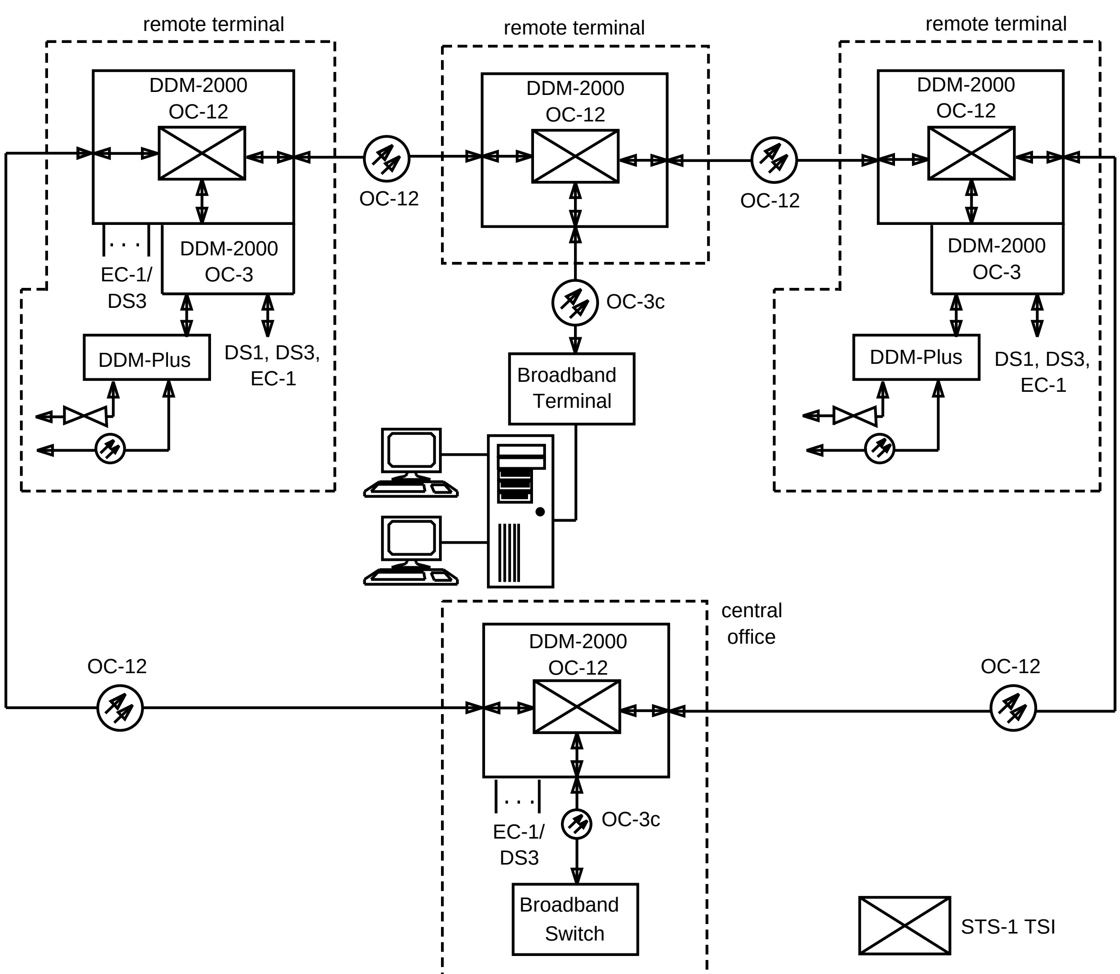

Figure 3-5. OC-12 Path Switched Ring — STS-1 Level Path Switching

Figure 3-6 shows how DDM-2000 OC-3 and OC-12 Multiplexers can be used together to provide a path switched ring operating simultaneously at the VT1.5, STS-1, and STS-3c levels. This ring is especially useful for loop feeder applications with large bandwidth needs. It can also be developed as a result of an upgrade from an OC-3 ring in an environment where growth has exhausted the bandwidth of the OC-3 ring.

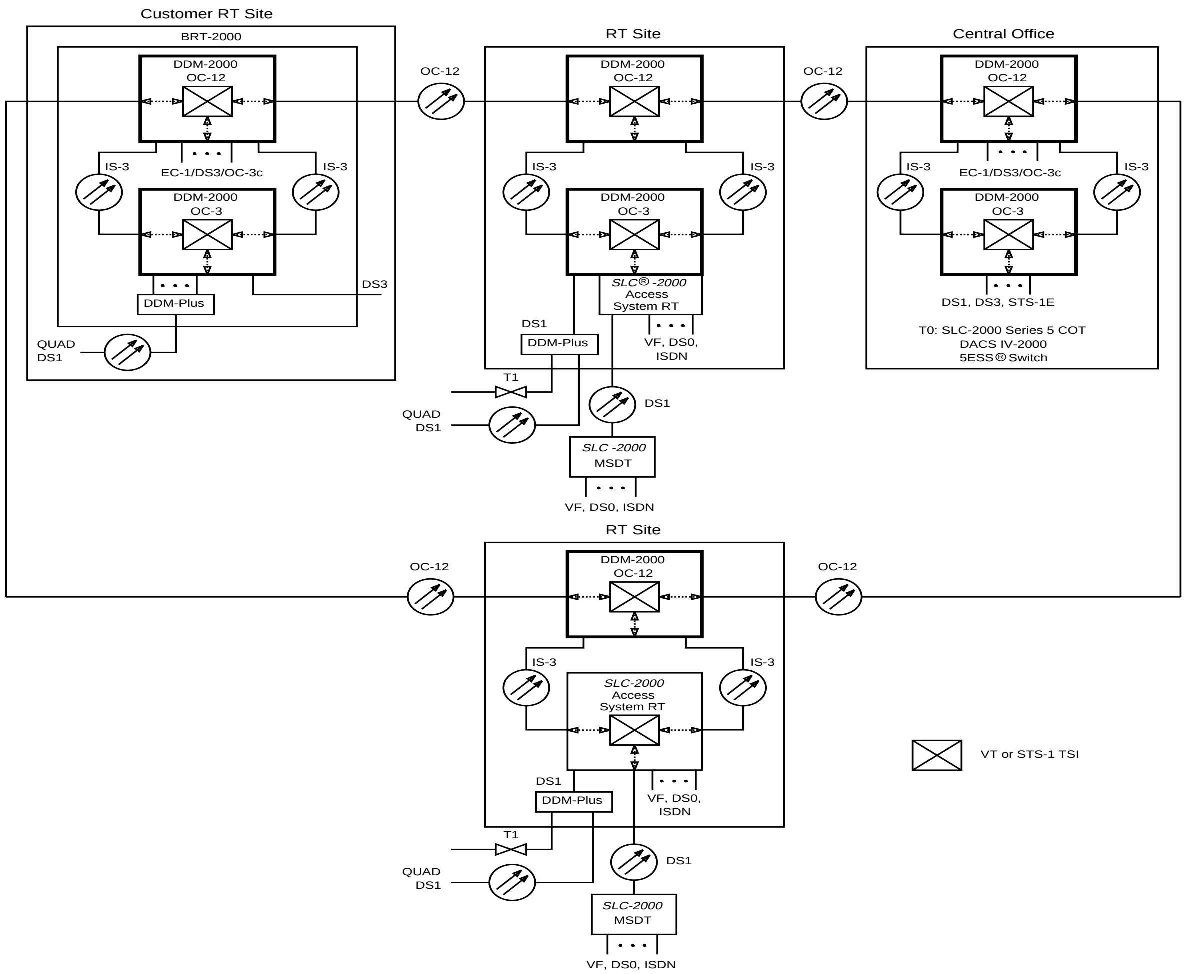

Figure 3-6. OC-12 Path Switched Ring Using OC-12 Multiplexer—Mixed STS-1 and VT1.5 Path Switching

Alternatively, a DDM-2000 OC-3 Multiplexer can be equipped with OC-12 optics. This option offers a cost-effective solution at locations where the dropped traffic is primarily VT1.5 based and is accessed from any three of the 12 STS-1s. OC-12

and OC-3 multiplexers equipped with OC-12 optics can be mixed in the same OC-12 ring. The OC-12 multiplexers can be used at sites requiring DS3 and other higher bandwidth STS path-switched traffic, while the OC-3 multiplexer is used at sites requiring VT path access for DS1, FiberReach, etc. Figure 3-7 shows an OC-12 ring that includes both OC-3 and OC-12 multiplexers.

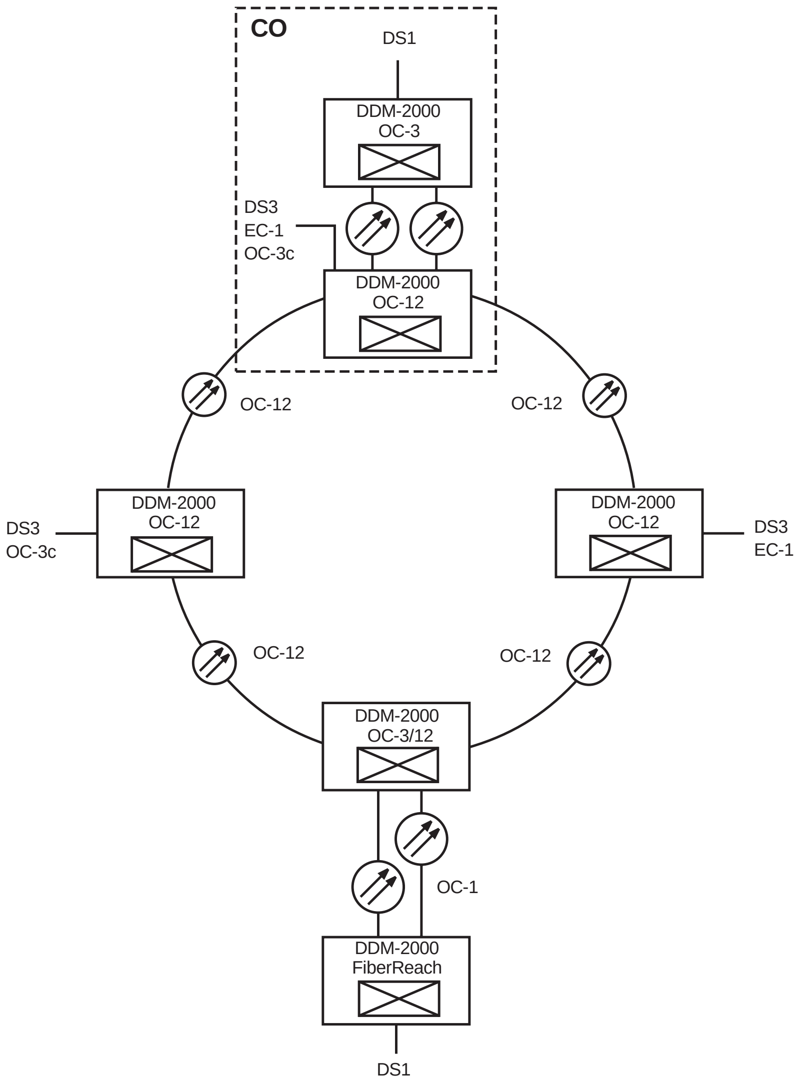

Figure 3-7. OC-12 Path Switched Ring Using OC-12 Multiplexer and OC-3 Multiplexer With OC-12 Optics

The OC-3 multiplexer with OC-12 optics may be used as an in-service upgrade to an OC-3 ring when traffic demand exceeds the 3 STS-1 capacity of an OC-3 ring. Figure 3-8 shows an OC-12 ring composed of OC-3 multiplexers equipped with OC-12 optics. This upgrade strategy quadruples the capacity of the ring using the existing fiber and OC-3 multiplexer shelves.

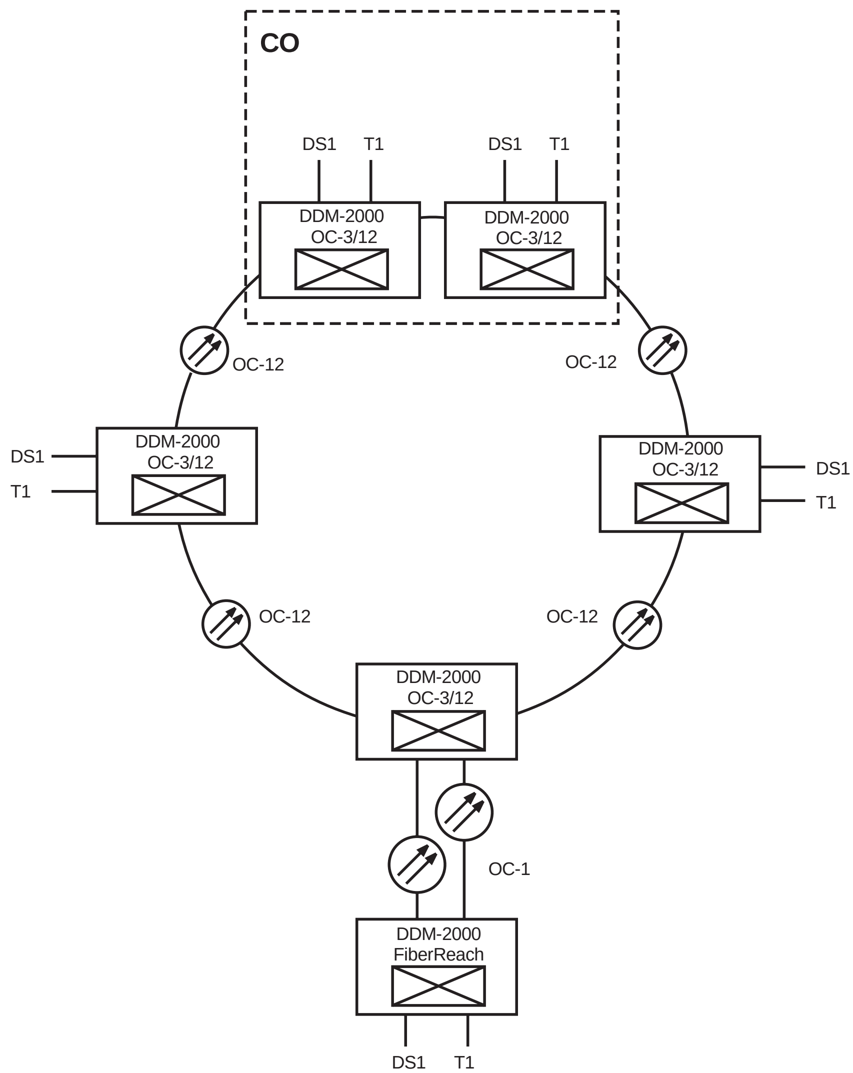

Figure 3-8. OC-12 VT Path Switched Ring Using DDM-2000 OC-3 Multiplexer With OC-12 Optics

Alternatively, a DDM-2000 FiberReach can be equipped with OC-12 optics. This option offers a cost effective solution at locations where the dropped traffic is primarily VT1.5 based and is accessed from any one of the 12 STS-1s. OC-12 and OC-3 multiplexers equipped with OC-12 optics can be mixed in the same OC-12 ring. The OC-12 multiplexers can be used at sites requiring DS3 and other higher bandwidth STS path-switched traffic, while the FiberReach multiplexer is used at sites requiring VT path access for DS1, T1, etc. Figure 3-9 shows an OC-12 ring that includes both OC-3, OC-12, and FiberReach multiplexers.

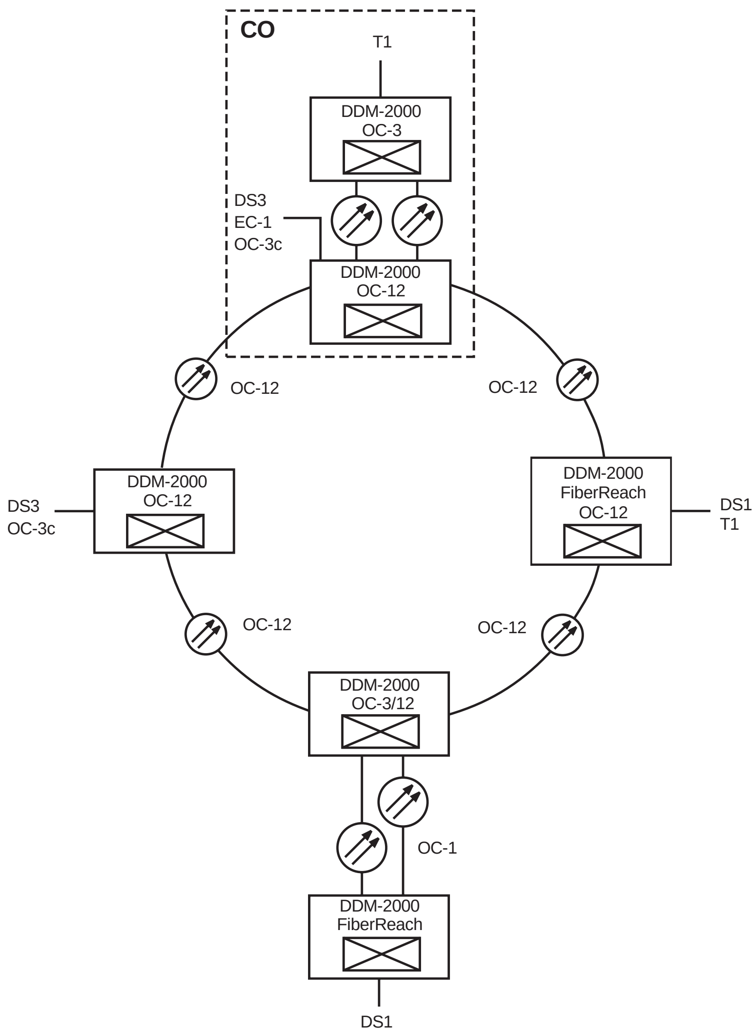

Figure 3-9. OC-12 Path Switched Ring Using DDM-2000 OC-12, OC-3, and FiberReach Multiplexers With OC-12 Optics

OC-3 Ring with OC-12 Ring Transport

If fiber exhaustion is a problem, the 2000 Product Family provides several alternatives for the network planners to pick from, depending on the specifics of their application. If fiber is available, multiple DDM-2000 OC-3 Multiplexer rings can be installed; or if fiber is unavailable or if the administrative ease of a single ring is desired, a single DDM-2000 OC-12 Multiplexer ring can be installed. Fiber exhaustion often occurs when customer demand for voice, DS1, and DS3 services grows to fill the OC-3 ring's capacity. If the growth has come from only one or two sites and there is spare fiber in place, these high demand sites may be cut to a new OC-3 ring without interrupting service. Alternatively, driven by fiber exhaustion or evolution to customer DS3 services, the OC-3 ring may be upgraded in service to an OC-12 ring. In this configuration (Figure 3-10), DDM-2000 OC-3 Multiplexer equipment is co-located with a DDM-2000 OC-12 Multiplexer shelf to provide a unified VT1.5 path switched ring node with an OC-12 high-speed interface.

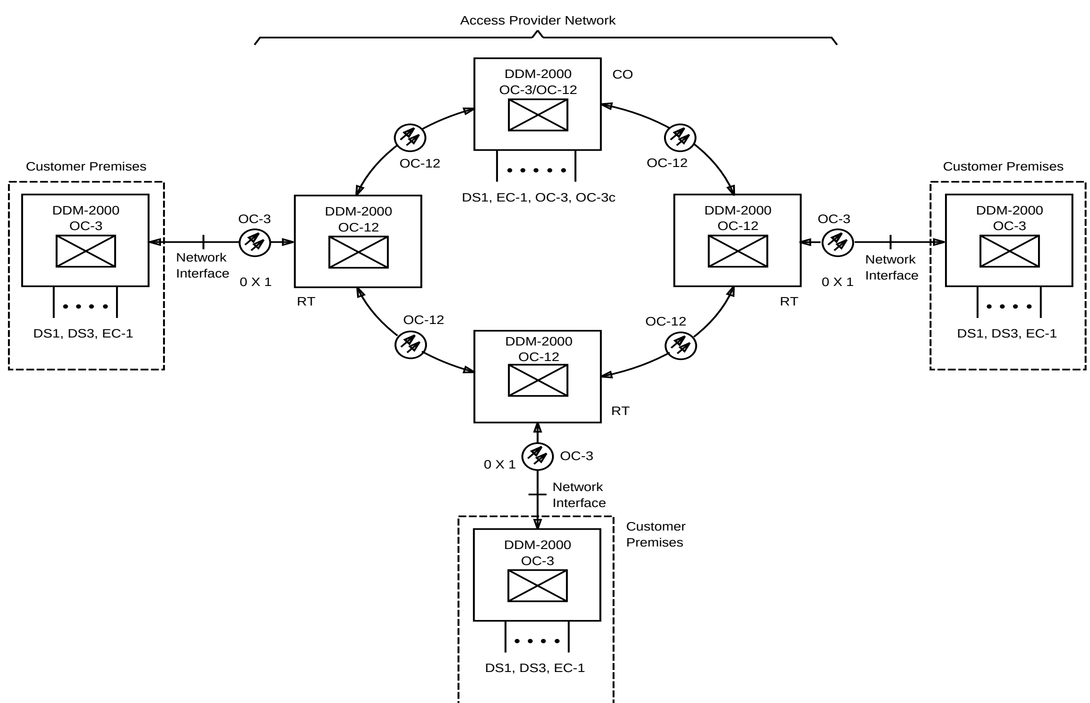

Figure 3-10. OC-3 Ring with OC-12 Ring Transport

VT1.5 bandwidth rearrangement is available which allows the unused VT1.5s from an STS-1 dropped at one site to be dropped at other sites. All DDM-2000 OC-3 and OC-12 Multiplexer shelves connected together in this subnetwork can communicate, using the single-ended operations capability of DDM-2000 Multiplexers. Once the DDM-2000 Multiplexer OC-12 ring is in place, it can be used by itself to provide STS-1 level path switching with DDM-2000 OC-3 Multiplexers to provide VT1.5 level path switching, or in a mixed configuration where both STS-1 level and VT1.5 level switching are supported simultaneously.

The link between the DDM-2000 OC-12 and OC-3 Multiplexers is 0x1 protected for this ring configuration. In this case, the DDM-2000 OC-12 Multiplexer feeds STS-1s directly off of each ring rotation to the DDM-2000 OC-3 Multiplexer where path switching is done. Switching is not done on the DDM-2000 OC-12 Multiplexer; rather VT1.5 or STS-1 level switching is done on the DDM-2000 OC-3 Multiplexer. Interconnecting the DDM-2000 OC-12 and OC-3 Multiplexers via a 0x1 interface allows the same STS-1 to be dropped to DDM-2000 OC-3 shelves at several nodes on the OC-12 ring. This combination of interconnected DDM-2000 OC-12 and OC-3 Multiplexers provides full VT1.5 switching granularity across the entire OC-12 bandwidth at any node on the ring, resulting in a full-fledged VT1.5 path switched OC-12 ring.

The DDM-2000 OC-12 path switched ring can be used in conjunction with the DDM-2000 OC-3 Multiplexer by an access provider to provide OC-3 ring service on an OC-12 ring for end users. It is becoming more frequent that a single end user desires a virtual private network from an access provider to connect several sites in a metropolitan area together. It is accomplished by deploying a DDM-2000 OC-12 ring in conjunction with DDM-2000 OC-3 Multiplexers. As described previously, the DDM-2000 OC-3 Multiplexers provide VT1.5 and STS-1 path switching; however, in this case, they are placed at end-user locations. The DDM-2000 OC-3 equipment is then used exclusively by that end user and three STS-1s worth of bandwidth are reserved on the OC-12 ring for that end user.

The end user is given logon privileges to the OC-3 equipment located on their premises, allowing them to gather performance data, provision service, and administer their virtual OC-3 ring network. From the end user's point of view, they have a virtual OC-3 ring network at their disposal.

For customers who have significant bandwidth demands or whose geographical situation requires additional OC-3 shelves from a single OC-12 location, Figure 3-11 shows how these applications can also be met. In addition, diverse routing to two separate OC-12 shelves can increase the reliability of the network even further.

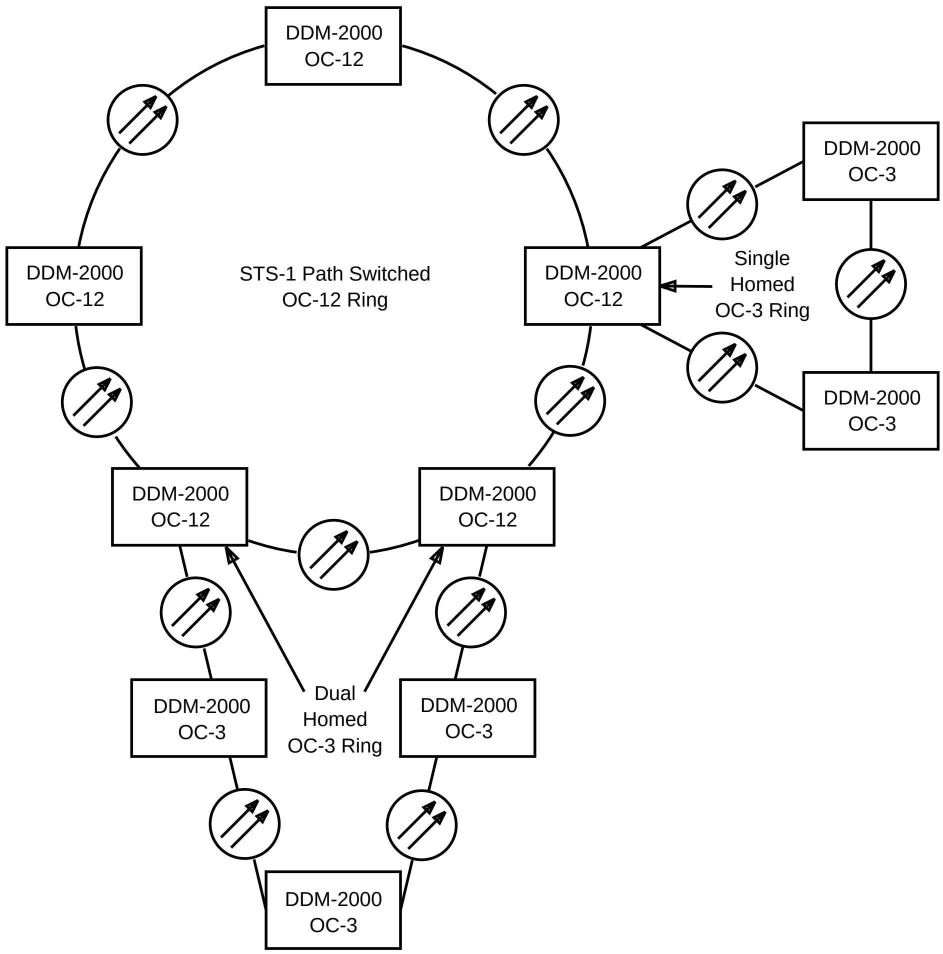

Figure 3-11. Multinode OC-3 Ring With OC-12 Ring Transport

The DDM-2000 OC-3 and OC-12 Multiplexers' path switched ring capabilities work together to provide cost-effective transport for small or medium cross-section interoffice networks such as outstate trunks. Such a ring, shown in Figure 3-12, provides DS1, DS3, EC-1, and OC-3c transport.

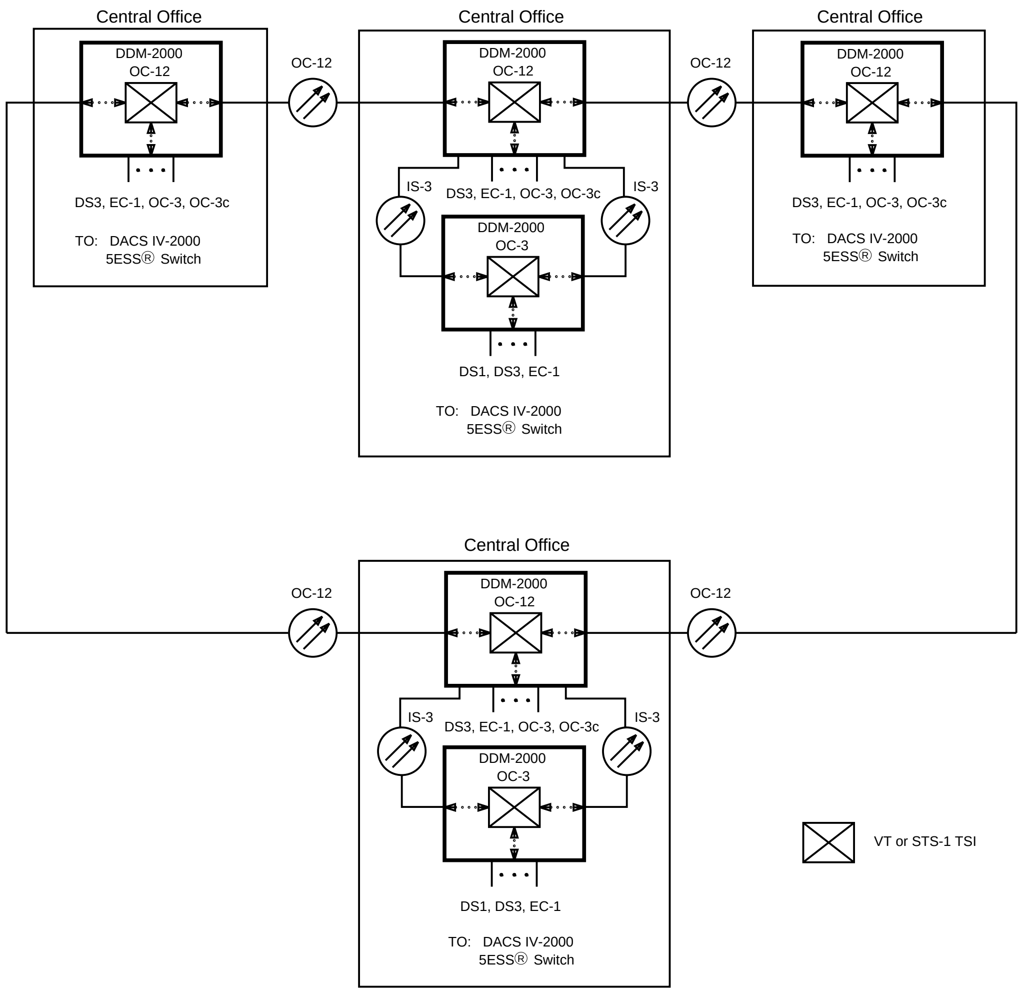

Figure 3-12. DDM-2000 OC-12 Path Switched Interoffice Ring

In a ring configuration, the DDM-2000 OC-12 Multiplexer can provide two high-speed optical interfaces. At a 1310 nm wavelength, it supports a span length of up to 51 kilometers (32 miles) without regenerators. At a 1550 nm wavelength, it supports a span length of up to 100 kilometers (61 miles) without regenerators. Regenerators or add/drop systems can be used to increase the distances for 1310 nm installations.

Each ring node can be independently synchronized from a Building Integrated Timing Supply (BITS) clock. This BITS clock can also be timed using the DDM-2000 DS1 timing output feature.

OC-12 STS-1/VT1.5 Path Switched Ring (0x1)

The DDM-2000 OC-12 ring supports (0x1) OC-3/IS-3 interfaces in its Function Unit slots. These interfaces must be provisioned as 0x1. Signals pass through the DDM-2000 OC-12 transport ring and exit to the DDM-2000 OC-3 ring. OC-12 Function Unit slot FN(x)-1 is connected to OC-3 Main-1 and OC-12 Function Unit slot FN(x)-2 is connected to OC-3 Main-2. Switching is not done on the DDM-2000 OC-12 Multiplexer on these lines, or paths on these lines; rather VT1.5 or STS-1 level path switching is done on the DDM-2000 OC-3 Multiplexer. This allows DDM-2000 OC-3 nodes running ring software to interface with DDM-2000 nodes of an OC-12 ring in such a way as to provide ring-on-ring architecture. Each OC-3 ring so supported occupies up to three STS-1 time slots on the OC-12 ring. Each OC-12 node can provision the same STS-1 time slots as other OC-12 nodes to drop to the OC-3 shelf (to share STS-1s among several OC-3 shelves) or the OC-12 node can provision different STS-1s at different sites. With 0x1 operation, the OC-12 ring passes the contents of these STS-1 time slots between the low-speed OC-3/IS-3 lines and OC-12 high-speed lines without terminating them or performing any path protection switching on them. Up to four OC-3 rings can be supported in this fashion by an OC-12 ring to maximize the OC-12 bandwidth utilization. This allows access to any and all VT1.5 signals at an OC-12 site. Since the high-speed signals from the OC-3 ring(s) are sent as two copies (one clockwise, the other counter-clockwise) on the OC-12 ring, the OC-12 ring capacity is limited to the OC-12 line rate.

The OC-3/IS-3 lines between an OC-12 node and an OC-3 node connected in a ring (0x1) fashion, behave like the OC-3 lines between the nodes on an OC-3 ring and do not perform line level protection switching. Instead, the OC-3 shelves perform the normal path protection switching functions.

The STS-1/VT1.5 0x1 feature has been added to DDM-2000 OC-3 Release 15.0 to allow a remote OC-3 or FiberReach shelf (FiberReach requires Release 4.0 for DCC) to interconnect through its Main ring interface to a host OC-3 shelf (Figure 3-13). The host shelf would be configured for OC-3 or OC-12, through OC-3 Low Speed interfaces in a single homed 0x1 configuration, or connect one or more remote OC-3 or FiberReach shelves would be connected through their

Main ring interfaces to two host OC-3 shelves through their OC-3 Low Speed interfaces in a dual homed 0x1 configuration.

Each OC-3 node provisions the same STS-1 time slots as the other OC-3 nodes on the same ring. With 0x1 application, the host OC-3 or OC-12 ring passes the content of the STS-1 time slots to the hosted OC-3 shelf(ves) without terminating them or performing protection switching on them. Ring path switching is not done on the DDM-2000 OC-3 ring; rather STS-1 level path switching is done elsewhere in the network.

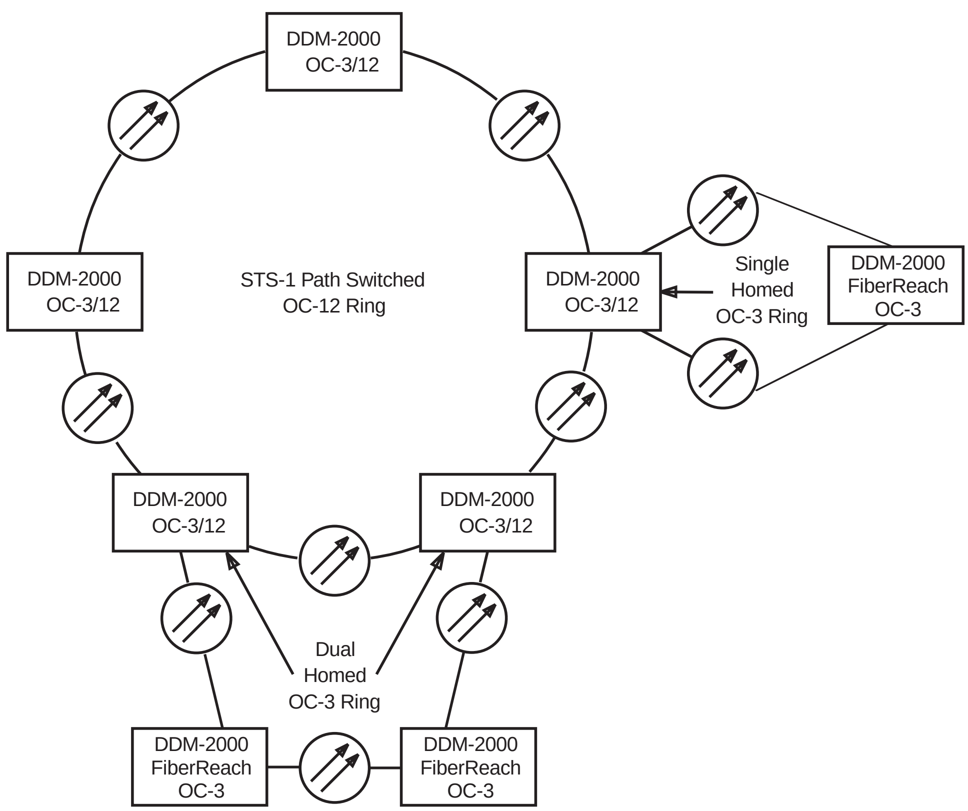

Figure 3-13. OC-12 Ring Transport (STS-1/VT1.5 0x1) With FiberReach OC-3 Rings

OC-1 Path Switched Ring

DDM-2000 FiberReach Multiplexers can be configured in an OC-1 path switched ring. The path switched OC-1 ring is best suited for DS1, DS0, and broadband channel transport in a campus or other self-contained environment where there is no need for the additional capacity and flexibility of an OC-3 backbone network. Folded Ring

DDM-2000 OC-3 and OC-12 rings offer several benefits in addition to service assurance. Economically, a ring network minimizes overall network cost by requiring fewer optical transmit/receive units than a comparable linear add/drop network. Operationally, a ring network provides significant flexibility to increase bandwidth at existing nodes and to add new nodes at locations where unanticipated bandwidth is required.

These benefits make rings highly desirable even when fiber route diversity is not available. When route diversity is not available on part or all of the ring, ring technology can be used to support split and tapered feeder routes to derive economic benefits, provide bandwidth flexibility, ease the process of adding and deleting nodes and supply survivability against single-node failures.

When route diversity is not available or fiber cable cuts are not a driving concern, the two-fiber path switched ring feature can be applied in a "folded" (a folded ring is a single path ring) configuration (Figure 3-14). This use of DDM-2000 OC-3, OC-12, and *SLC*-2000 access resource manager (ARM) path switched rings applies in particular to hubbing and linear topologies where there is no return path from the end remote site to the CO. While a complete cut through the fiber cable cannot be protected, single-node equipment failures are still protected. Furthermore, a two-fiber ring ARM uses only one optical transmitter/receiver in each direction (two per remote shelf), in contrast to a 1+1 line protection arrangement that requires four optical transmitter/receivers per remote shelf. Thus the ring configuration reduces equipment costs, a benefit independent of its survivability advantage. The ring topology also makes node addition/deletion straightforward.

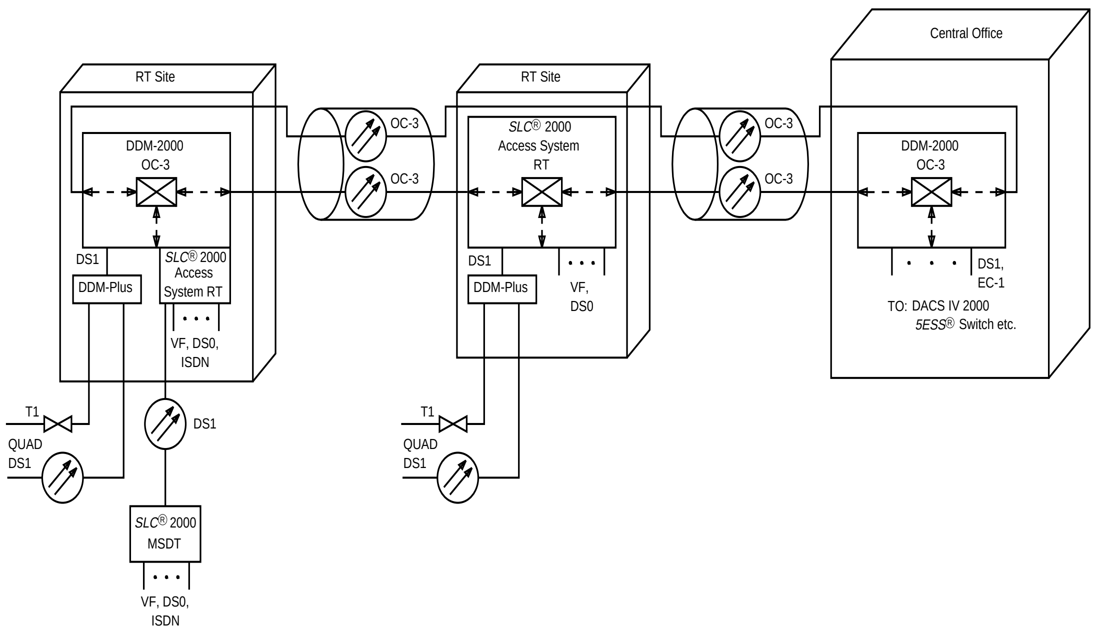

Figure 3-14. Folded Ring Configuration

OC-1 Ring Transport on OC-3 Ring

OC-1 ring transport on OC-3 rings can be used in both single-homed and dual-homed configurations. Figure 3-15 shows how single-homed OC-1 extensions can satisfy a growing access network. Single-homing applications connect both rotations of the OC-1 extension to a single DDM-2000 OC-3 or *SLC*-2000 Access System host. The DDM-2000 FiberReach is located at the customer's location, such as in a telecommunications equipment closet on each floor of a high-rise office complex, and delivers up to 16 fully protected DS1 channels per system.

The OC-1 ring capability allows multiple DDM-2000 FiberReach systems to be connected to the backbone network via a single facility. Compared to other optical extension products that are limited to a single remote node per extension, the ring-based DDM-2000 FiberReach solution uses far less fiber and host optics for typical serving areas with multiple business locations. Network growth is as easy as adding another DDM-2000 FiberReach node on the ring; no additional fiber or host circuit packs need to be added.

With the dual OC-1 capability of the 27-type OLIU, a DDM-2000 OC-3 ring node supports up to six single-homed OC-1 extensions; a *SLC*-2000 Access System ARM shelf can supply up to two single-homed OC-1 extensions. Thus, competing businesses in the same serving area can receive a dedicated access facility into the backbone ring, alleviating any privacy concerns.

The single OC-1 26G2-U OLIU further expands the options by allowing the dropping of DS1s without the need for the MXRVO or BBF5 Jumper circuit packs (a Group 4 shelf is required).

The DDM-2000 FiberReach remote systems employ standard path protection switching for a highly reliable network that guarantees 60 millisecond recovery from any single facility or equipment failure. Path protection switching occurs at the nodes where a channel is dropped from the ring to a low-speed interface. Channels pass between the OC-1 and OC-3 rings at the host DDM-2000 OC-3 and *SLC*-2000 systems with a 0x1 low-speed cross-connection. This arrangement supports full TSI assignment between low-speed and high-speed time slots while preserving independent service and protection paths between the host and extension rings.

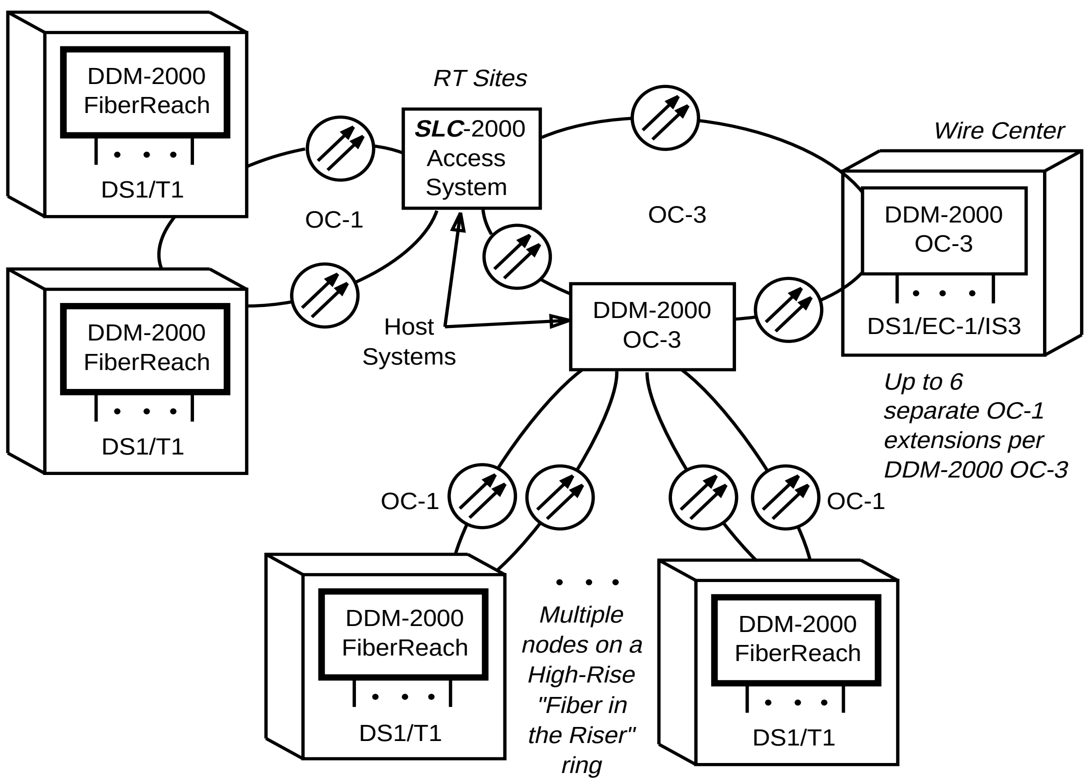

Figure 3-15. OC-1 Ring Transport on OC-3 Ring Configuration

Single Homing to Linear DDM-2000 OC-3 Networks

In business applications where the DDM-2000 OC-3 host is a node on a linear topology, two single-homed OC-1 ring extensions can be provided to multiple DDM-2000 FiberReach Multiplexers as shown in Figure 3-16. In this tapered linear application configuration, function slot “C” of the DDM-2000 OC-3 host is used for incoming traffic, and the “A” and “B” slots are used for downstream traffic or local terminations. The host DDM-2000 OC-3 Multiplexer must be using software Release 9.0 or later. The other DDM-2000 OC-3 Multiplexer in the linear application must be using Release 8.0 software.

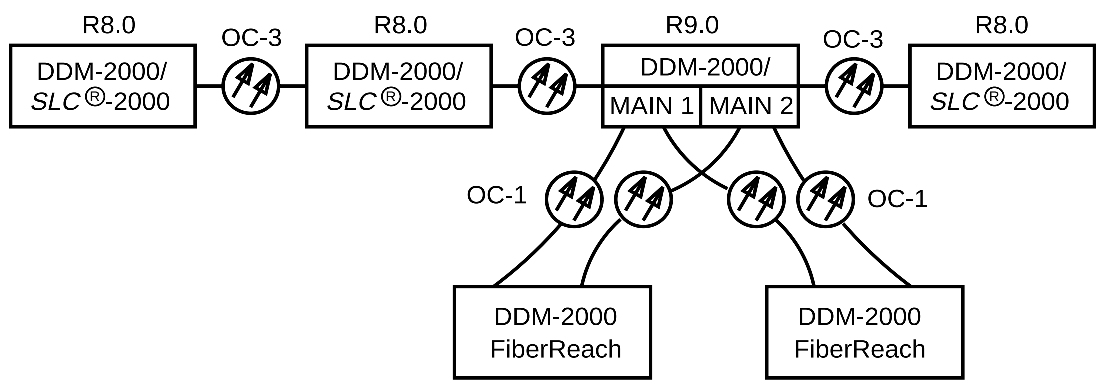

Figure 3-16. Single-Homed OC-1 Ring to a DDM-2000 OC-3 Linear Application

Stand-Alone OC-1 Ring/Hub Networks

In applications such as campus or other self-contained environments, DDM-2000 FiberReach can be deployed in a stand-alone OC-1 ring. This OC-1 ring extension can be configured directly from a DDM-2000/*SLC*-2000 shelf with 27-type OLIUs in the main slots. A mix of DS1 and T1 carrier traffic from remote DDM-2000 FiberReach nodes can be flexibly groomed and dropped at the host to a mix of DS1, EC-1, and OC-3 interfaces, as shown in Figure 3-17. Channels can be established directly between two DDM-2000 FiberReach remotes on the same OC-1 ring. This configuration would be very effective for customers within a short radius of the wire center or for isolated demand at a distant location where there is no appropriate access network yet in place.

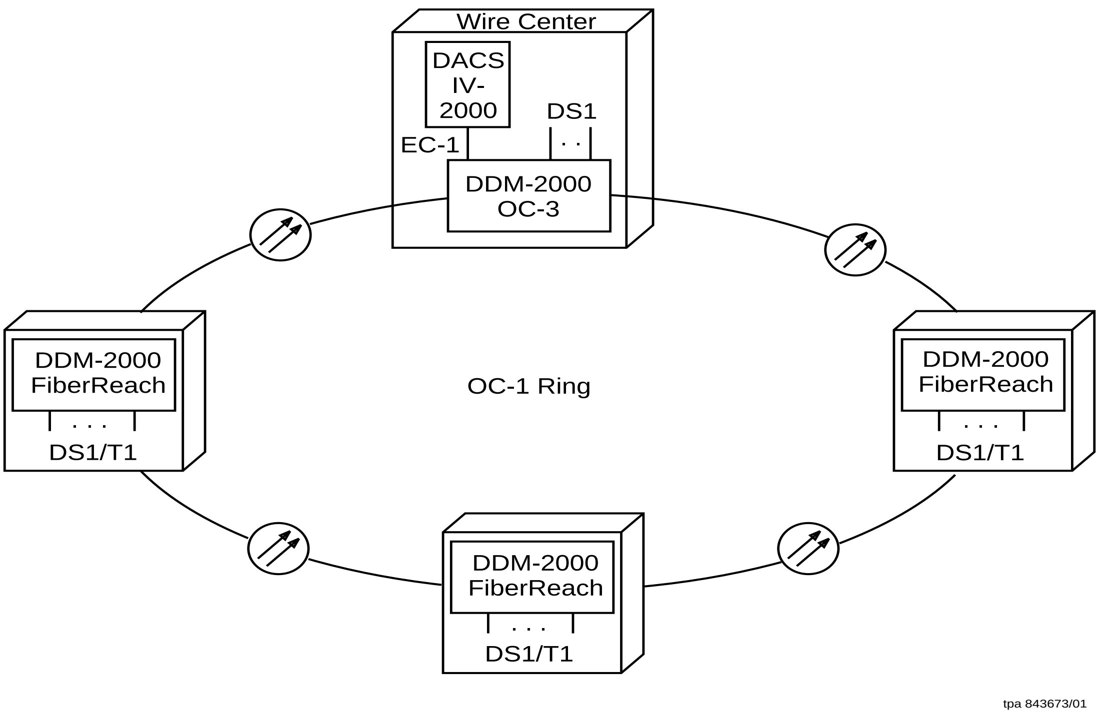

Figure 3-17. DDM-2000 FiberReach Stand-Alone OC-1 Ring

This application can be further expanded to hub up to two OC-1 rings from a stand-alone DDM-2000/*SLC*-2000 host system, as shown in Figure 3-18.

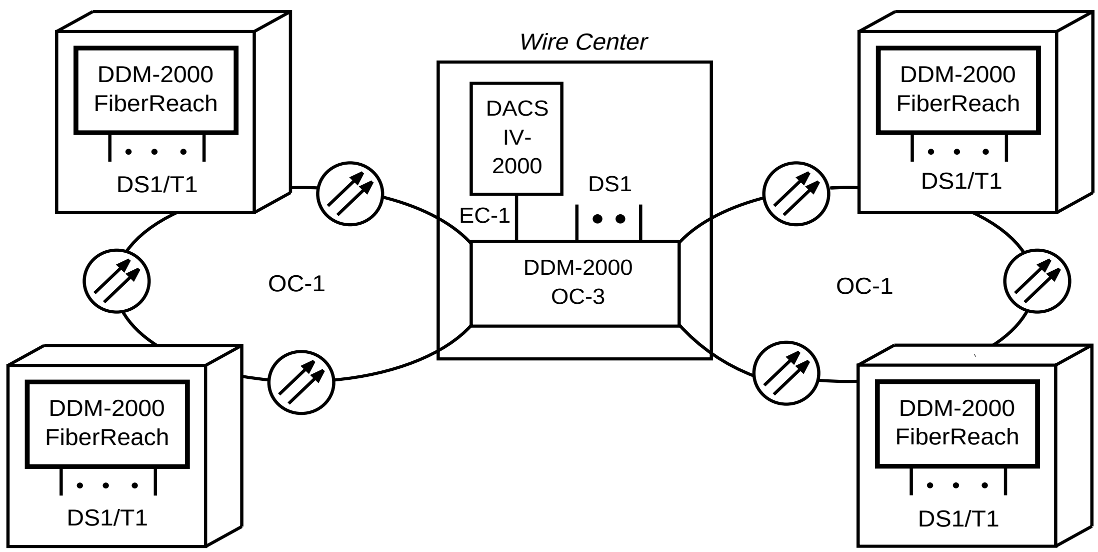

Figure 3-18. DDM-2000 FiberReach Single Homing to a Stand-Alone OC-1 Hub Host

OC-3 Ring Transport on OC-12 Point-to-Point

Rings that cover a large geographical area or interconnected path switched rings are a cost effective and popular way for a service provider to offer these high priority services. Figure 3-19 shows a ring configuration using DDM-2000 OC-3 ring nodes with DDM-2000 OC-12 point-to-point nodes to provide a high-service availability architecture. This configuration will survive fiber, equipment, and catastrophic office failure since it provides an alternative service path through a secondary CO and uses the path switching ability of the DDM-2000 OC-3 to select between these two paths.

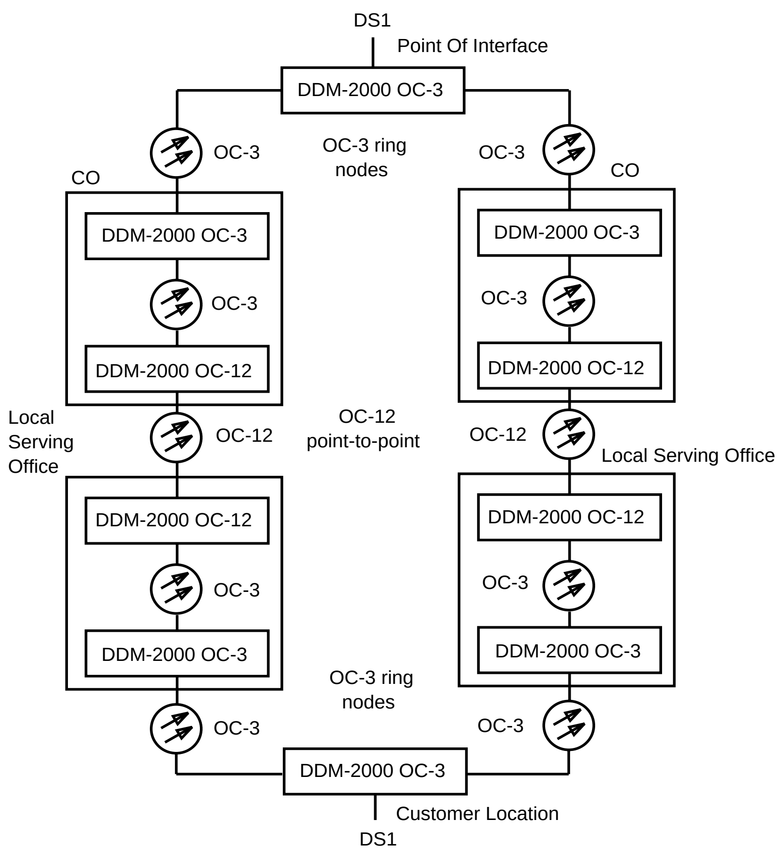

Figure 3-19. OC-3 Ring Transport on OC-12 Point-to-Point

Dual Homing

End-users are demanding service with higher and higher availability. Service providers are responding with tariffs that rely on self-healing networks to offer such high availability service. Some of these tariffs even call for penalties for the service provider when service is interrupted or has a high error rate. The Lucent SONET product family offers many options for meeting these service needs.

OC-1 Ring transport on OC-3 Ring and OC-3 Ring transport on OC-12 ring networks can be implemented in dual homing configurations.

OC-1 Ring Transport on OC-3 Ring

Dual homing offers even more survivability than a single-homed network, as even the catastrophic failure of a host node can be protected. Figure 3-20 shows a dual-homed OC-1 extension from two remote nodes on an OC-3/OC-12 access ring. OC-1 extensions from OC-12 rings are available in R11 using OC-12 optics in the OC-3 shelf. The host nodes can be two DDM-2000 OC-3/OC-12 or two *SLC*-2000 Access Systems, or one DDM-2000 OC-3/OC-12 Multiplexer and one *SLC*-2000 Access System.

Path protection switching is employed for dual-homed applications, just like in single-homed applications. That is, 60 millisecond path switching is supplied by the remote DDM-2000 FiberReach nodes and the DDM-2000 OC-3 or OC-12 systems in the wire center. The OC-3 host node configuration differs from that used for single-homing because each host node terminates only one leg of the OC-1 extension. At each host node, a connection is made from the single OC-1 extension to just one rotation of the OC-3/OC-12 host ring. Dual- and single-homed extensions can also be mixed at a host node, allowing the access network to be tailored efficiently to different groups of customers.

Dual and single-homed extensions can also be mixed at a host node, allowing the access network to be tailored efficiently to different groups of customers.

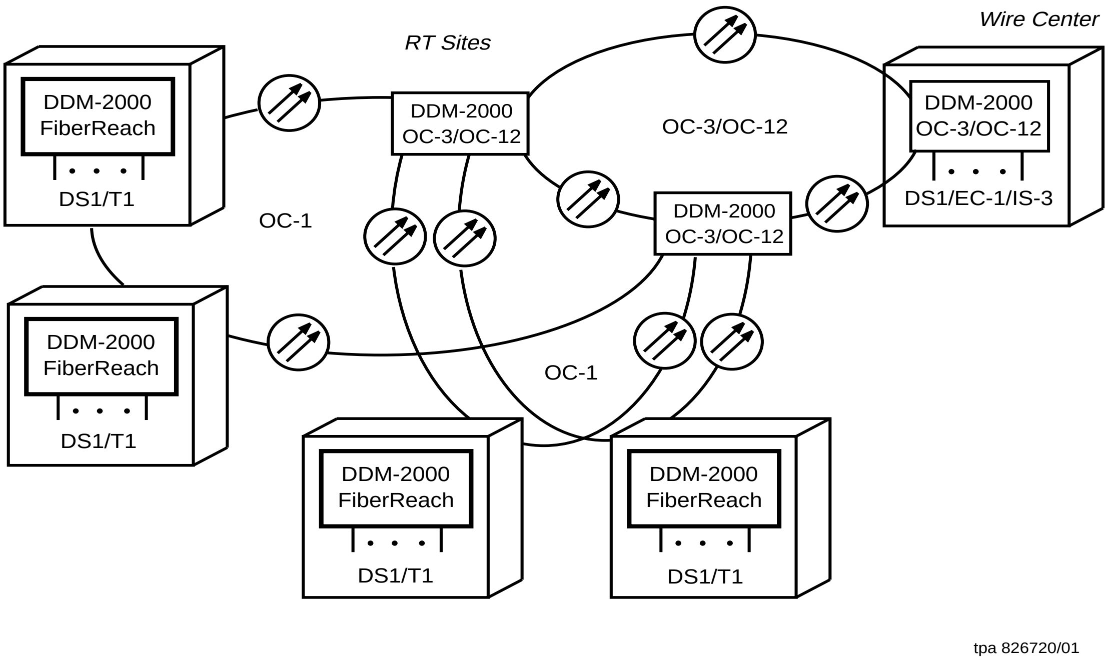

Figure 3-20. DDM-2000 FiberReach Dual Homing to a DDM-2000 OC-3 Ring

Dual Ring Interworking (DRI)

In an interconnected ring or DRI topology two rings are connected together at two geographically separate nodes. In addition to the facility and node failure protection that a single ring provides, the dual node interconnection between the rings provides an automatic alternate route in the event of a catastrophic failure at one of the interconnecting nodes. Typically, such a topology is used to interconnect a loop feeder access ring to a higher bandwidth interoffice ring as shown in Figure 3-21. This architecture can withstand any single equipment or fiber failure in each of the rings or a failure (which could range from a CO shutdown in the case of fire, for example, or equipment failure, or failure of the facility connecting the two rings) of either of the two interconnecting nodes without losing service on either the access ring or the interoffice ring. Such a catastrophic failure would cause a service outage for a simple ring architecture.

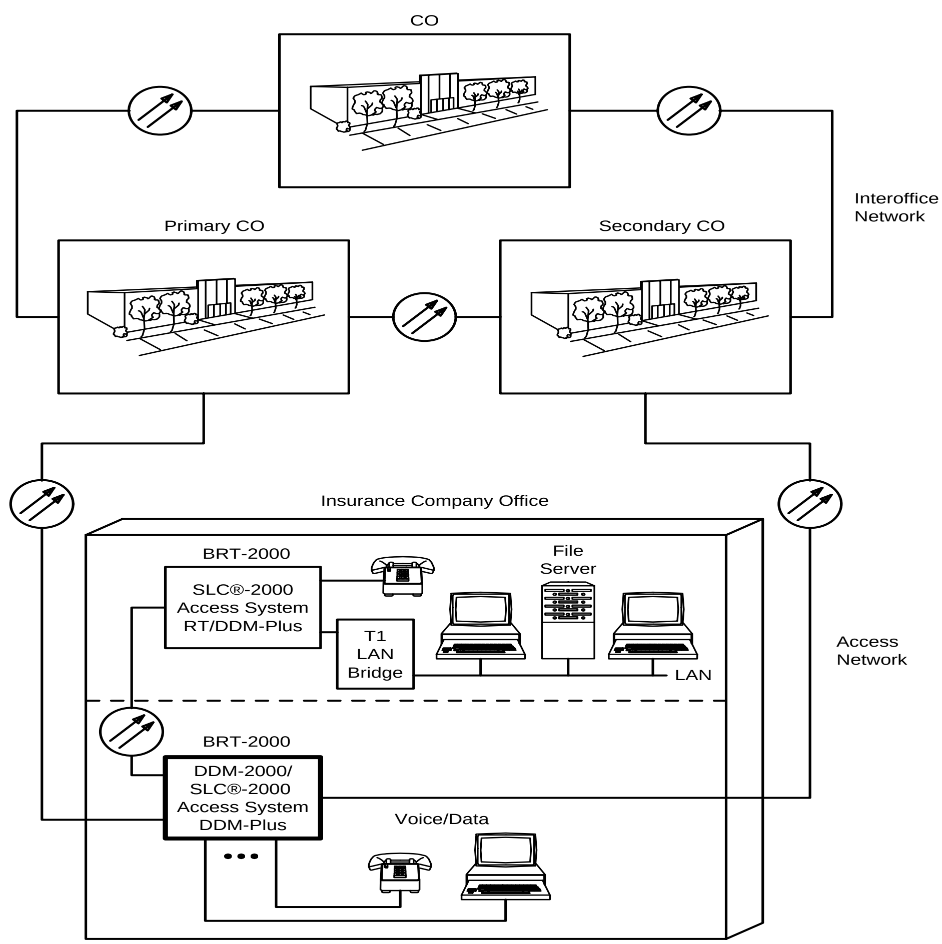

Figure 3-21. Dual Access Configuration

As Figure 3-22 shows, DRI allows a circuit (for instance, between nodes A and Z) with one termination in the upper ring and the other termination in the lower ring to survive a failure of the shared node that is currently carrying service for the circuit. The failure is depicted by an "X" in the figure. The two shared nodes are in CO B and CO C. Both nodes have the signal available to them at all times. When a failure occurs, the two terminating nodes and the two shared nodes switch so that traffic is carried through CO C and around the node failure.

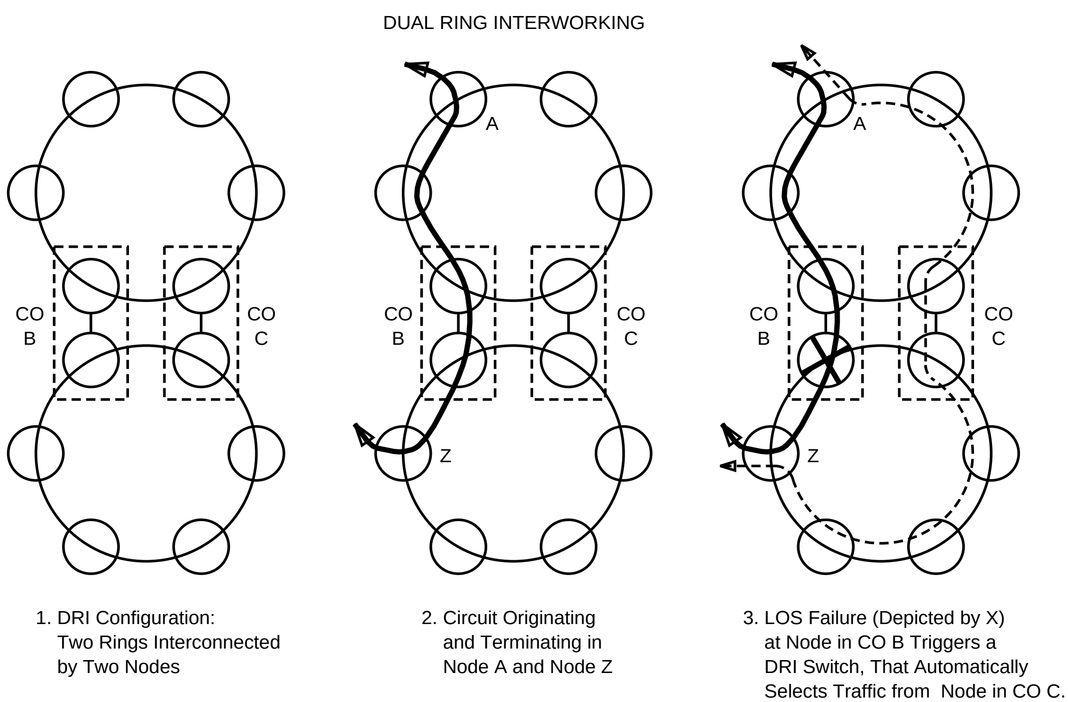

Figure 3-22. Dual Ring Interworking Concepts

DDM-2000 OC-3, OC-12, and FT-2000 OC-48 Lightwave Systems can be configured to offer this topology. Often the DDM-2000 equipment is used for the loop feeder access ring, and the FT-2000 OC-48 Lightwave System equipment is used for the interoffice ring. Figure 3-23 shows a DDM-2000 OC-3 (or OC-12) path switched ring interworking with an FT-2000 OC-48 Lightwave System bidirectional line-switched ring.

The DDM-2000 OC-12 Multiplexer also supports DS3 DRI in addition to the EC-1 and OC-3 interfaces. In the event of a DS3 failure, the OC-12 Multiplexer inserts an STS-1 AIS signal into the STS-1 ring channel used by the DS3 to activate the downstream STS path protection switch.

In this application, the DDM-2000 provides an appearance of loop traffic at both the primary and secondary nodes by dropping traffic at the primary node and simultaneously continuing it on to the secondary node. This capability is called "drop-and-continue." The DDM-2000 OC-3 Multiplexer allows DS1 signals to be multiplexed for handoff at an economical EC-1 or OC-3 rate in the COs. Also, the DDM-2000 OC-3's flexible TSI can be used to prepackage all DRI protected DS1s into a single EC-1 for economical handoff to the OC-48 ring. This capability allows for the easy mixing of DRI and non-DRI services on the same ring network. In this way, only specially tariffed services need to be configured for the extra reliability that DRI provides. DS3/STS1 clear channel services are also supported. The companion FT-2000 OC-48 Lightwave System ring picks up the traffic at these two nodes and carries it to the destination node, unless a failure condition causes a protection switch to the secondary signal. In the reverse direction, a similar process is followed with the OC-48 ring handing off the two copies of the signal at the primary and secondary nodes and the OC-3 ring providing the switching at the destination node.

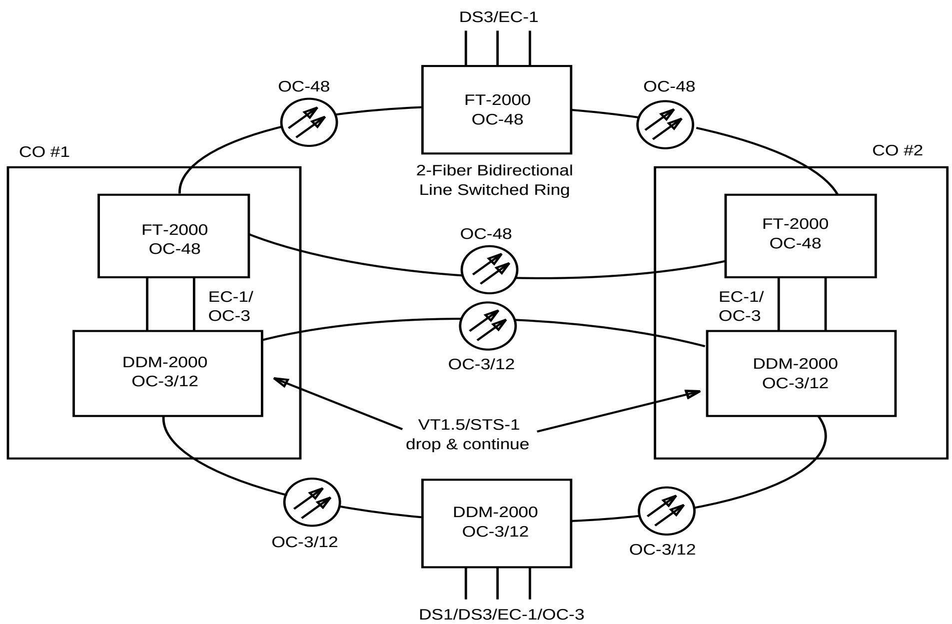

Figure 3-23. OC-3/12 to FT-2000 OC-48 Lightwave System Dual Ring Interworking

The DDM-2000 drop-and-continue feature also finds an excellent application in interconnecting two rings via an intermediate transport network. In the example shown in Figure 3-24, DDM-2000 OC-3 Multiplexer access rings act as a DRI pair via an FT-2000 OC-48 Lightwave System and DACS IV-2000 interoffice network. The advantage of this network is the grooming for DRI traffic provided by the DACS IV-2000. Both DDM-2000 OC-3 rings provide drop and continue at each of their two duplicate COs. Both copies of the signal are transported as separate tributaries through the interoffice network, and path switching is implemented at the edges of the network. Signal redundancy is preserved on an end-to-end basis.

In offices where SONET interconnections are not available, DS3 interfaces can be used between dual OC-12 offices. This architecture is not recommended over the all SONET architecture, since DS3 interface failures are potentially service affecting.

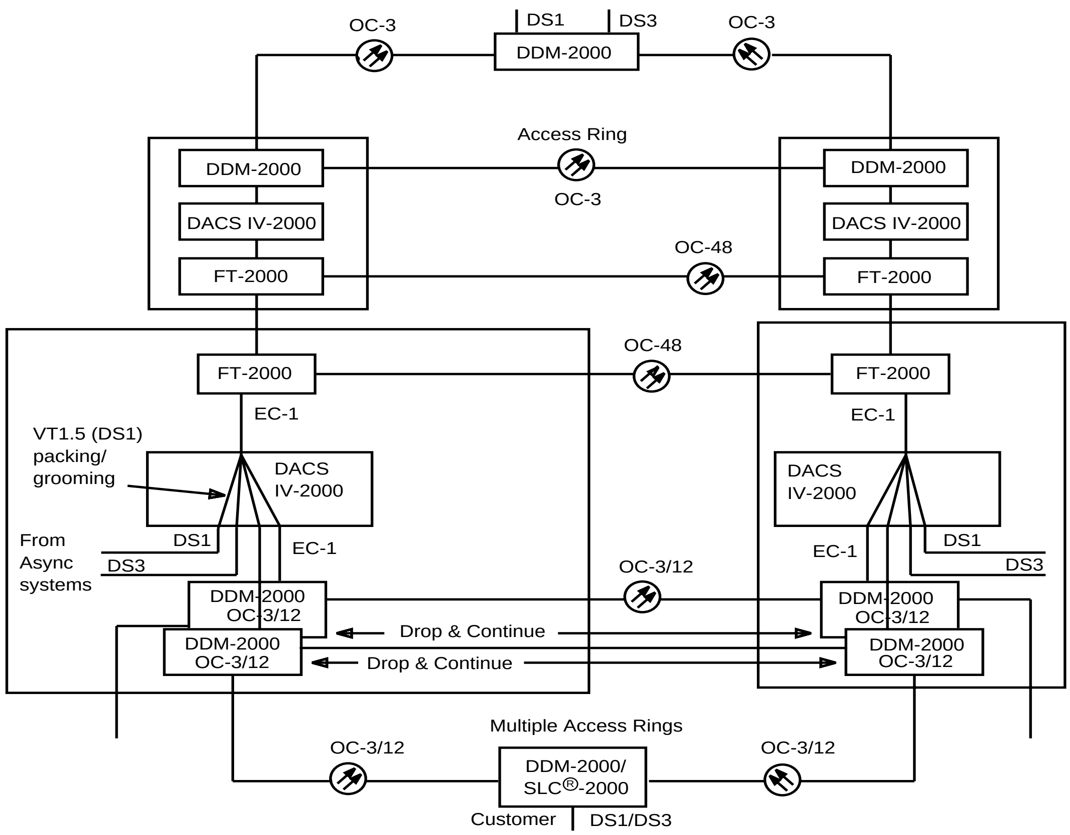

Figure 3-24. DDM-2000 Ring Interworking with FT-2000 OC-48 Lightwave System Transport and DACS IV-2000 Grooming

Dual Homing with DRI

The survivability and networking benefits of Lucent's DRI solution are cost-effectively extended to smaller locations via DDM-2000 FiberReach dual-homing capabilities. Figure 3-25 shows an OC-3 feeder ring from duplicated wire centers, with dual-homed DDM-2000 FiberReach extensions from selected feeder ring remote sites.

The host nodes and remote DDM-2000 FiberReach systems are configured just like the previously described dual-homing configuration with single 0x1 cross-connections employed by the host. In the dual wire center architecture, the access network is also protected from a catastrophic failure of one wire center, because the access and interoffice networks have duplicate points of interworking. The DDM-2000 OC-3 systems in the two wire centers employ the drop and continue cross-connection.

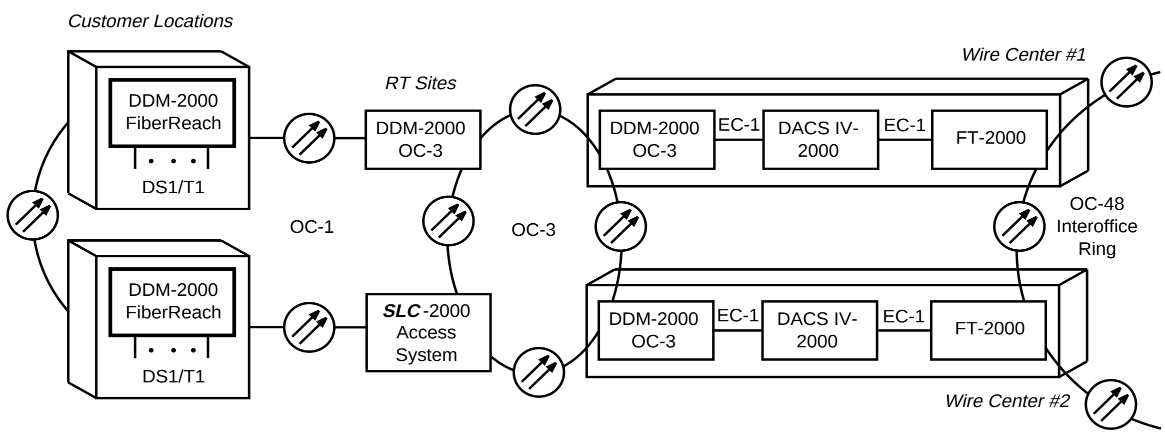

Figure 3-25. DDM-2000 FiberReach Ring Dual Homing to a DDM-2000 OC-3 Ring in a Dual Wire Center Application

OC-3/OC-12 Linear Optical Extensions from OC-3, OC-12, and FT-2000 Rings

An additional topological flexibility offered by the DDM-2000 OC-3 and OC-12 Multiplexers is 1+1 protected or unprotected linear OC-3 and IS-3 optical extensions from OC-3, OC-12, and FT-2000 rings. Using this capability, the DDM-2000 OC-3 and OC-12 Multiplexers can support many of the new network configurations desired in the evolving loop feeder environment. As Figure 3-26 and Figure 3-27 shows, an access provider can use linear optical extensions from an OC-12 or FT-2000 ring to provide OC-3/OC-3c signals directly to end users. This gives the end users the bandwidth they need for large bandwidth applications, such as video, and provides it to them via the path switched ring architecture they require for high service availability. If enabled, full single-ended operations are available on all NEs. This gives the end user full control of performance monitoring (PM) data, network reconfigurations, and provisioning of the network.

OC-3 optical extensions can also be used to interconnect SONET subnetworks. Examples include interconnection of two access networks and interconnection between access and interoffice rings. Optical extensions can be used to interconnect OC-3 and OC-12 ring subnetworks to an OC-3 terminal, OC-3 and OC-12 add/drop networks, and another OC-3, OC-12,or FT-2000 ring.

The DDM-2000 OC-3 Release 15.0 allows the Main OC-3/OC-12 ring interface on the DDM-2000 OC-3 shelf to support “identical” DCC data link mode. This will allow an OC-3 shelf to interconnect through its Main ring interface to an OC-N 1+1 interface on another NE(Function Unit of host NE). The user must provision the remote (hosted) OC-3 NE for “identical” DCC mode on the Main interfaces. Only protected OC-3 interfaces are supported. This allows a TARP extension using Release 15.0 ring software, easier upgrade from existing linear extensions, eliminates the need for a DDM-2000 path switching element on the other end of FT-2000 OC-48 ring, reduced FT-2000 OC-48 bandwidth needed, and saves FT-2000 DCC terminations.

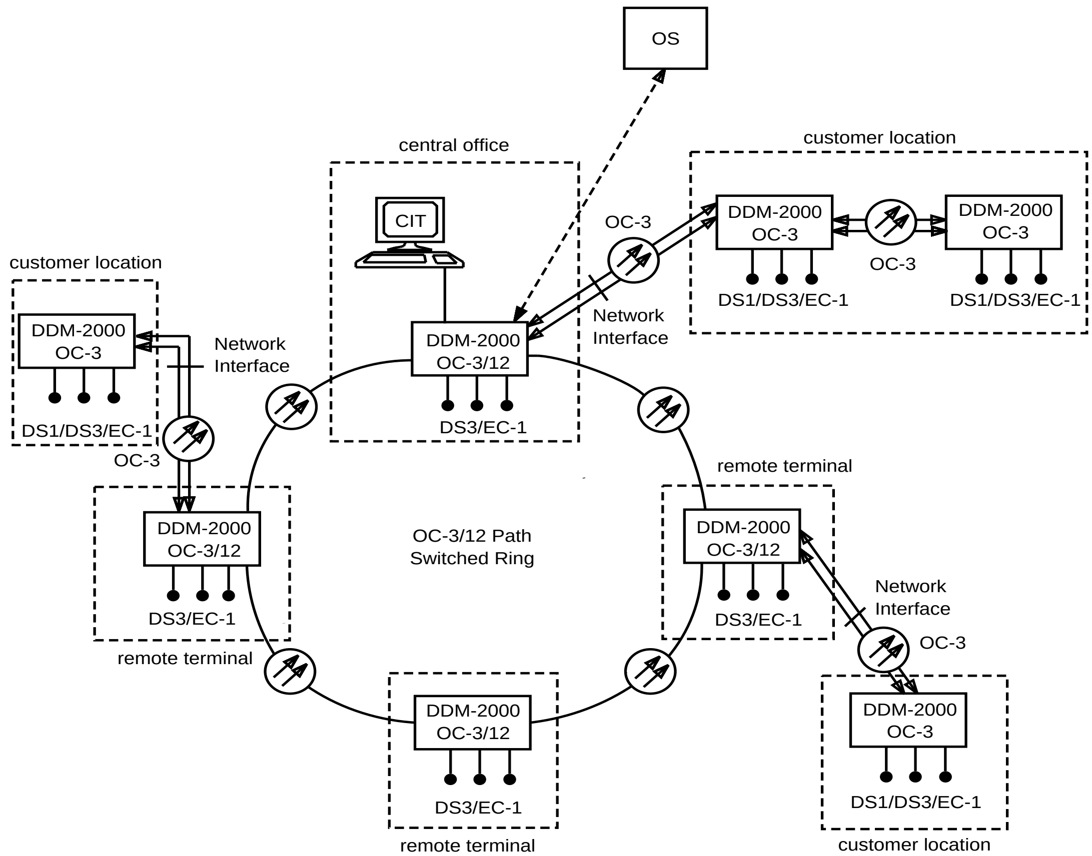

Figure 3-26. OC-3 Services Using Linear Optical Extensions From OC-3/OC-12 Ring

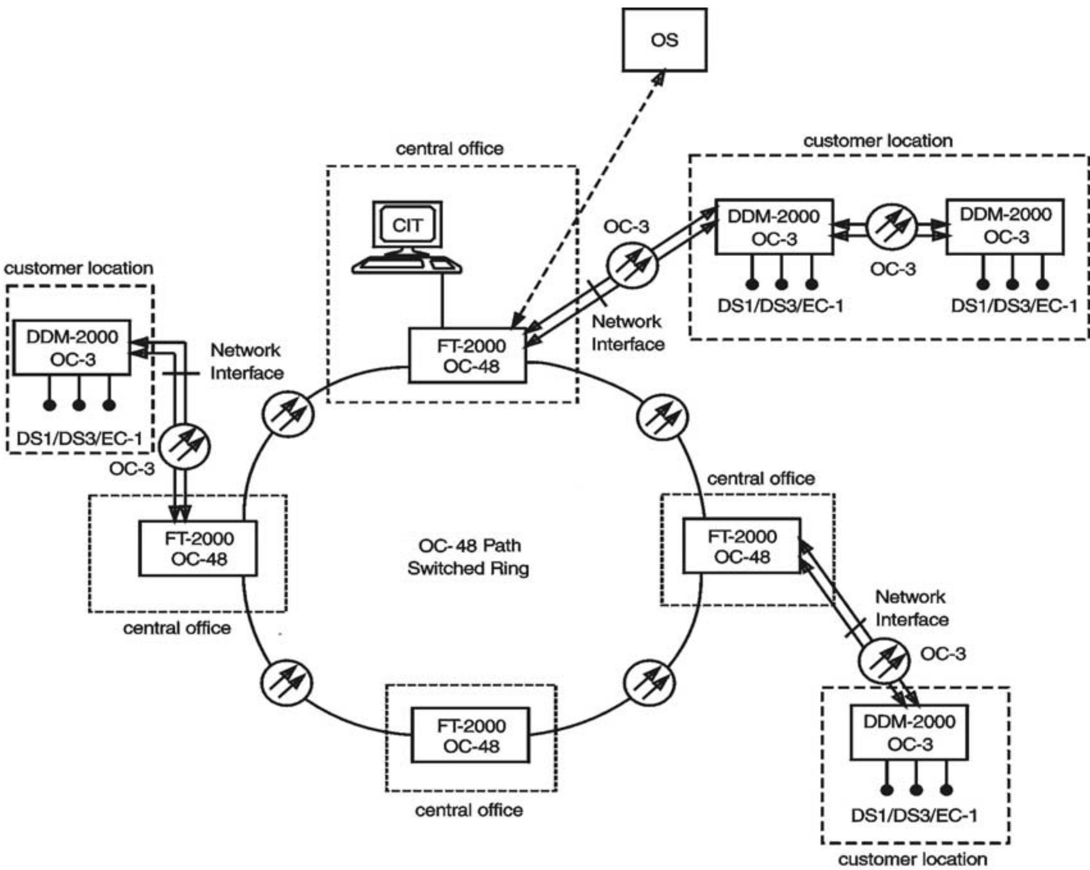

Figure 3-27. OC-3 Services Using Linear Optical Extensions From FT-2000 Ring

Hairpin Cross-Connections on Rings

The DDM-2000 OC-3 Multiplexer supports a VT1.5/STS-1 "hairpin" cross-connection where VT1.5/STS-1 signals from one Function Unit can be cross-connected to VT1.5/STS-1 signals in another Function Unit. Figure 3-28 shows a hairpin cross-connection between Function Unit C and Function Unit A or Function Unit C and Function Unit B.

The advantage of hairpin cross-connections is equipment savings. If there is a need to access a DS1 within an OC-3 signal, rather than install another OC-3 shelf, you can use the unused Function Unit slots in any other OC-3 shelf. This type of cross-connection does not use any time slots on the OC-3 ring itself.

Figure 3-28 also shows how hairpin cross-connections can be used on a ring. Hairpin cross-connections can also be used in ring configurations with multiple optical extensions to provide a hubbing topology with a ring at the hub.

See Section 4, "Product Description," for more information on hairpin cross-connections.

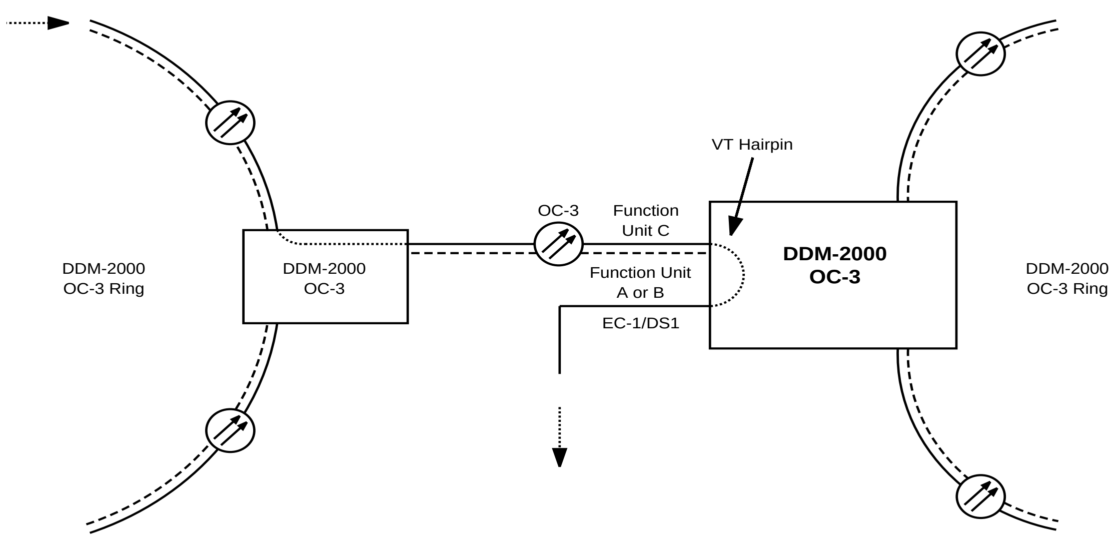

Figure 3-28. VT1.5 Hairpin Cross-Connections

Enhanced Routing

DDM-2000 FiberReach hosts can support a collection of enhanced routing features as shown in Figure 3-29, Figure 3-30, Figure 3-31, and Figure 3-32. These features support cross-connections within and across function units without using bandwidth on the main OC-3 or OC-12 rings. This allows even greater networking flexibility and efficiency. While the high-speed OC-3 interface can carry up to 84 VT1.5 channels, each of the 3 function units has a two OC-1 capacity, or up to an additional 168 VT1.5 channels. For example, a DDM-2000 OC-3 system with 22-type OLIUs in the main slots and 27G2-U dual OC-1 OLIUs in each function unit supports up to 168 VT1.5 channels: 84 between high-speed OC-3 and low-speed OC-1, and another 84 channels that pass directly between this host's remote FiberReach system.

The OC-1 ring interconnection enhanced routing options utilize 0x1 or pass-through cross-connections at the DDM-2000 host. Path protection switching is performed at the DDM-2000 FiberReach systems at the path endpoints. The local drop enhanced routing option employs path protection switching in the OC-3 host's function unit in order to drop to local EC-1, DS1, or OC-3 ports. This local drop option requires the use of Release 11.0 or later software at the DDM-2000 host.

OC-1 Ring Pass-Through

This enhanced routing option establishes pass-through cross-connections for channels on an OC-1 ring terminating on a pair of 27G2-U OLIUs in a function unit as shown in Figure 3-29. These cross-connections are just like the pass-through cross-connections that can be provisioned for rings terminating on main slots. This allows traffic to be routed from one FiberReach node to another FiberReach node on the same OC-1 ring without using bandwidth on the OC-3/OC-12 ring.

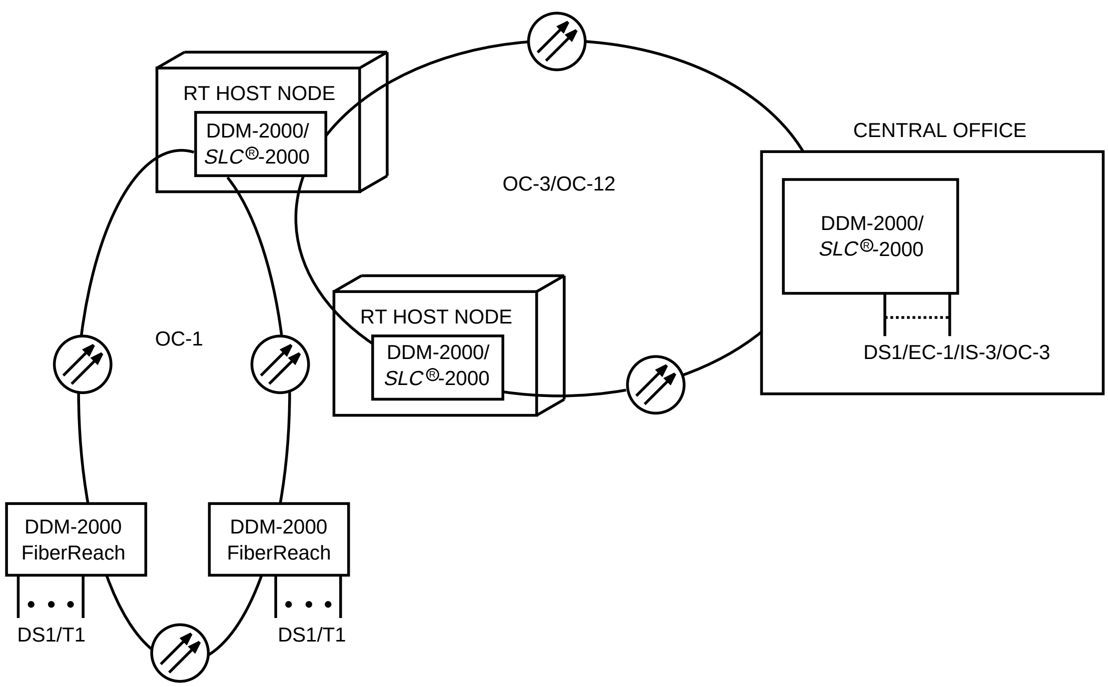

Figure 3-29. OC-1 Ring Pass-Through in a Function Unit

OC-1 Ring Hairpin Routing, Single-Homed

This routing option establishes cross-connections between channels on two separate OC-1 facilities that terminate on 27G2-U OLIU circuit packs, in either the same or different function units as shown in Figure 3-30. In the single-homed configuration, both rotations of each of the two OC-1 rings terminate on a pair of 27G2-U OLIUs. There may be a single pair of 27G2-U OLIUs that terminates both rings, or one pair of 27G2-U OLIUs in each of two function units that terminates the rings. Each rotation of one ring is cross-connected to the corresponding rotation of the other ring. This allows traffic to be routed from one FiberReach node on one OC-1 ring, to any other FiberReach node on another OC-1 ring, without using bandwidth on the OC-3/OC-12 ring.

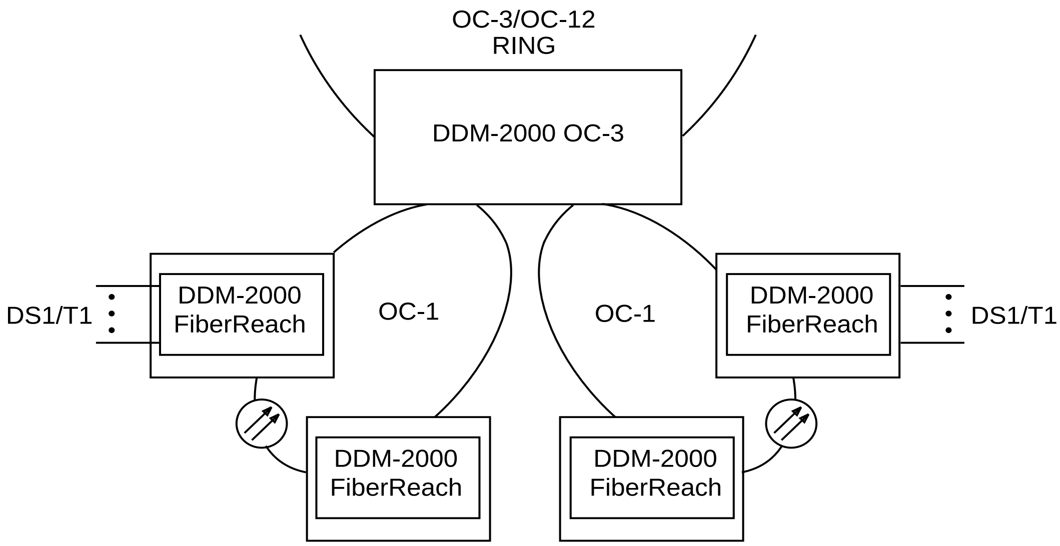

Figure 3-30. Single-Homed Hairpin Routing

OC-1 Ring Hairpin Routing, Dual-Homed

With this routing option, shown in Figure 3-31, cross-connections are established between channels on two separate OC-1 facilities that terminate on 27G2-U OLIU circuit packs in either the same or different function units. In the dual-homed arrangement, only one rotation of each of the two OC-1 rings terminates on a single OC-3 shelf. At the OC-3 shelf, there may be a single 27G2-U OLIU that terminates both rings or a 27G2-U OLIU in each of two function units that terminates the rings. The other rotation of each ring terminates on a different OC-3 shelf. This allows traffic to be routed from one FiberReach node on one OC-1 ring to any other FiberReach node on another OC-1 ring without using bandwidth on the OC-3/OC-12 ring.

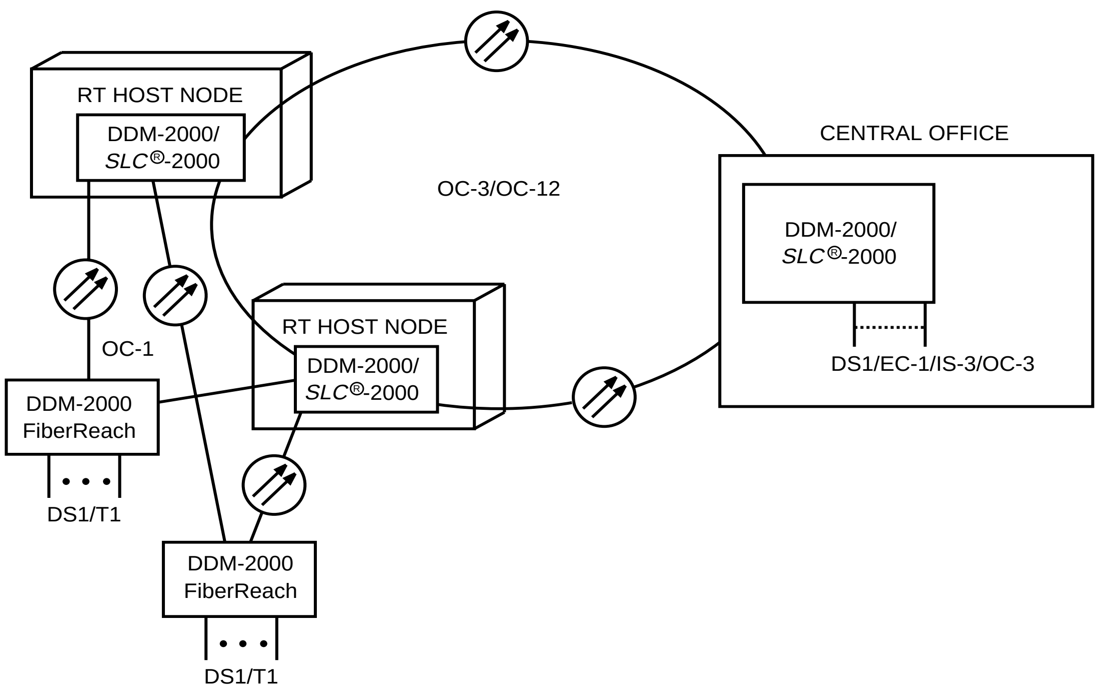

Figure 3-31. Dual-Homed Hairpin Routing

Hairpin Local Drop Routing

Figure 3-32 shows hairpin local drop routing. In this configuration, path-protection switched drop cross-connections are established between channels on an OC-1 ring and ports/channels on DS1/EC1/OC-3 circuit packs. The OC-1 facility terminates on a pair of 27G2-U OLIU circuit packs in a function unit. These connections are just like the drop cross-connections that can be established between channels on a ring terminating on the main slots and ports or channels in a function unit. This allows traffic to be routed from a FiberReach node on an OC-1 ring to a local drop without using bandwidth on the OC-3/OC-12 ring.

A mix of the enhanced routing services shown in Figure 3-29, Figure 3-30, Figure 3-31, and Figure 3-32 can be created in a single DDM-2000 FiberReach host. OC-3 Release 11.0 or later software and 27G2-U OLIUs are needed for these services.

Beginning with Release 13.0, the single OC-1 26G2-U OLIU, with built-in multiplexer capabilities, further expands the options by allowing the dropping of DS1s without the need for the MXRVO or BBF5 Jumper circuit packs (a Group 4 shelf is required).

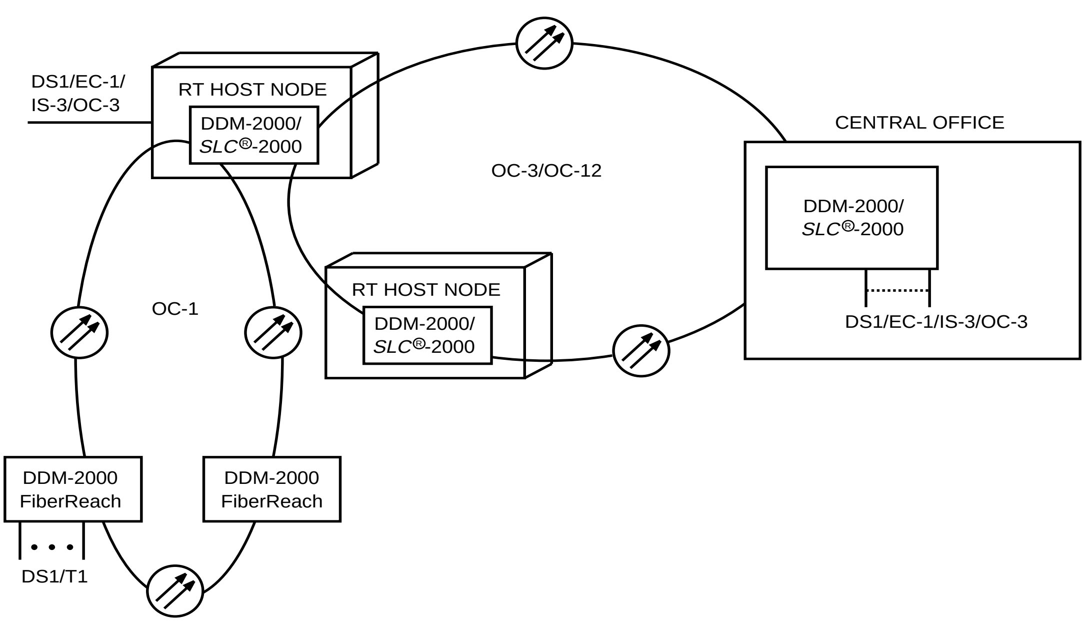

Figure 3-32. Hairpin Local Drop Routing

Point-to-Point Topologies

OC-3 Point-to-Point

The point-to-point application is the traditional means of providing optical transport in the loop feeder. In situations where new demand is isolated to a small number of carrier-serving areas along a given feeder route, maximum simplicity and cost efficiency make point-to-point configurations a good choice. The point-to-point application has the added benefit of consistency with existing operations systems and operations practices.

The point-to-point applications provide an ideal platform from which the loop network can evolve in step with changing service needs. Evolution to multispan applications like add/drop, hubbing, and path switched rings offers planning flexibility and network equipment savings. Starting at the OC-3 rate, the access network can be sized to maximize utilization with an easy upgrade to higher capacities like OC-12.

The DDM-2000 OC-3 point-to-point topology builds on the solid base established by the DDM-1000 Multiplexer. A single 8.5-inch shelf provides OC-3 optical transport for a mix of DS1 and DS3 traffic. Equipped in this manner, the DDM-2000 OC-3 Multiplexer is a low-cost, full-function terminal. The OC-3 point-to-point network (Figure 3-33) consists of OC-3 Multiplexers in the CO and RT sites, connected by four single-mode or multimode fibers (two service, two protection). At the RT site, the OC-3 Multiplexer typically interfaces to digital loop carrier systems like the *SLC* Series 5 Carrier System. DS1 extensions to customer premises or another RT site are provided by the DDM-Plus low-speed extension shelf or DDM-2000 FiberReach, with a choice of DS1 line repeaters or quad DS1 optical interfaces. DDM-Plus optical interfaces can be terminated at a DDM-Plus extension shelf or a DDM-Plus distant terminal.

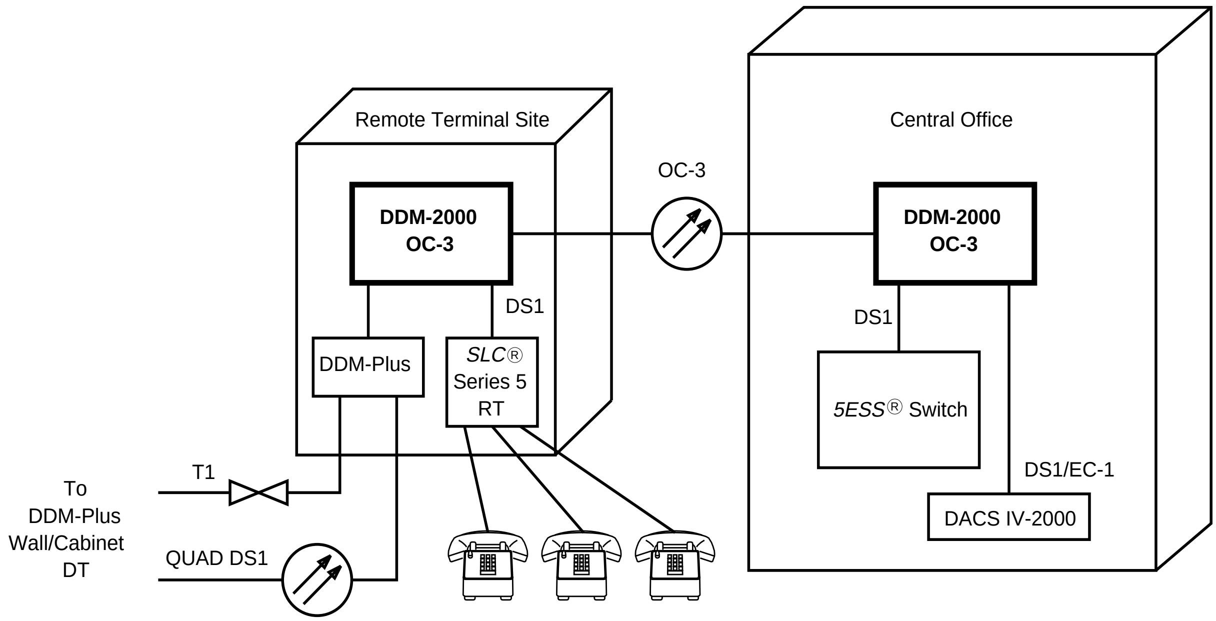

Figure 3-33. OC-3 Point-to-Point Topology

Figure 3-34 and Figure 3-35 show two typical applications in a metropolitan high-rise, where an OC-3 point-to-point network runs from the CO to the customer's building. Figure 3-34 shows an initial application with preexisting copper wiring in the building risers. From a basement cabinet, the DDM-2000 OC-3 Multiplexer and DDM-Plus or DDM-2000 FiberReach provide direct DS1 service over this wiring to cabinets on the floors above.

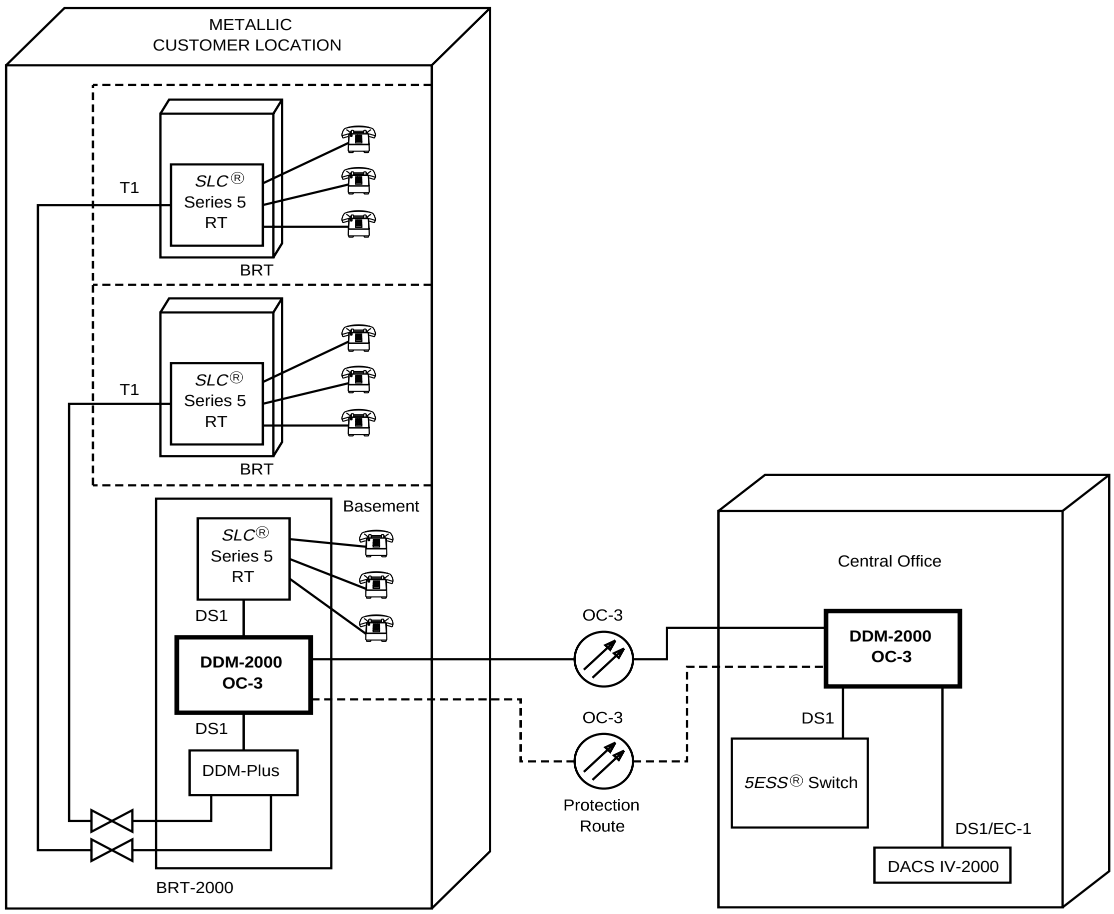

Figure 3-34. Metro Application — Copper in the Riser

Figure 3-35 shows a larger application with fiber in the riser, using the optical extension capability of DDM-Plus or DDM-2000 FiberReach, to extend optical bandwidth to individual floors. Satellite locations contain the DDM-Plus distant terminal (DT) to convert the optical extension interface into four standard DS1 signals. Self-healing needs can be met with cabled ring or diverse routing. The OC-3 bandwidth to customer locations also positions the network to deliver higher bandwidth services, such as video.

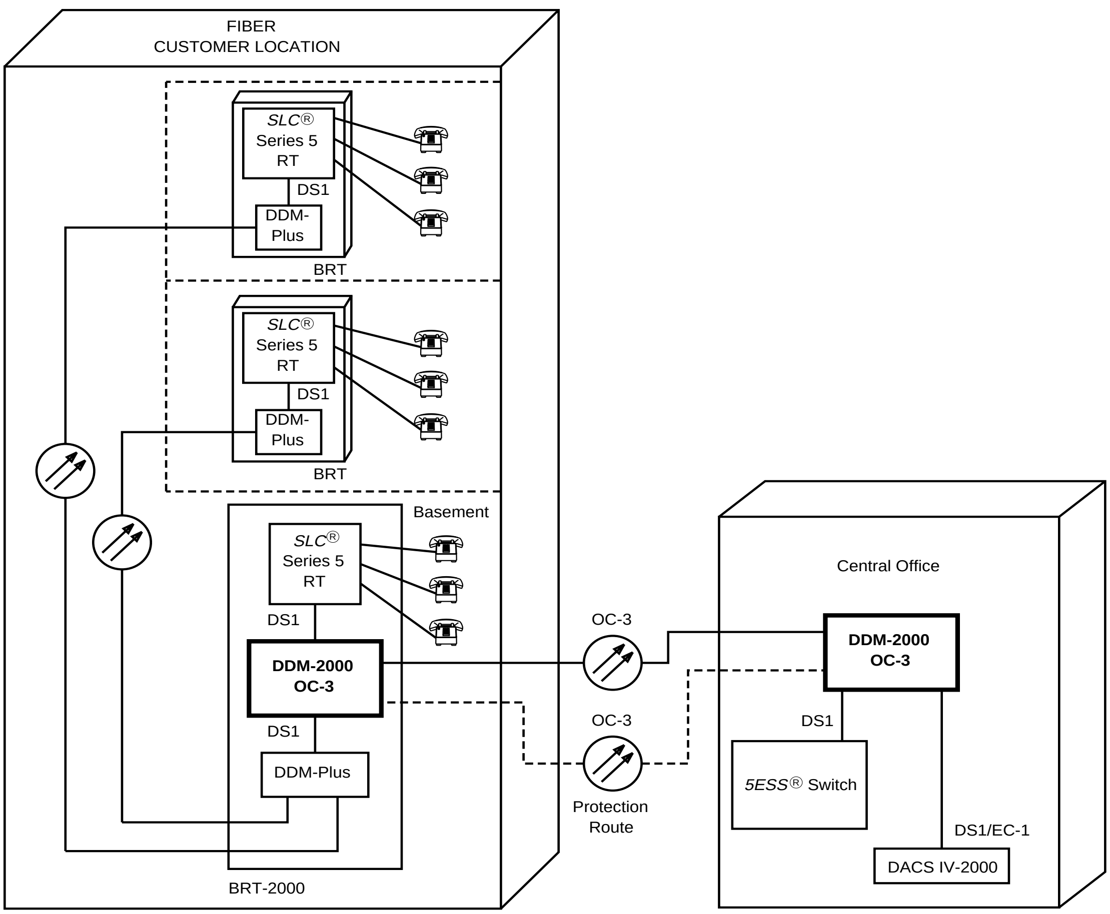

Figure 3-35. Metro Application — Fiber in the Riser

DDM-2000 OC-3 and DDM-Plus or DDM-2000 FiberReach systems provide bandwidth features to improve the delivery of CENTREX services. In a multisite campus application (Figure 3-36), *SLC* Series 5 Carrier System RTs and DDM-Plus optical extensions carry voice traffic from each building to a DDM-2000 OC-3 Multiplexer at a conveniently located remote terminal site. The DDM-2000 OC-3 Multiplexer provides economical and reliable access to the serving *5ESS*® switch. The OC-3 capacity supports a growing campus, as up to 84 DS1s (2016 voice channels) can be provisioned as needed.

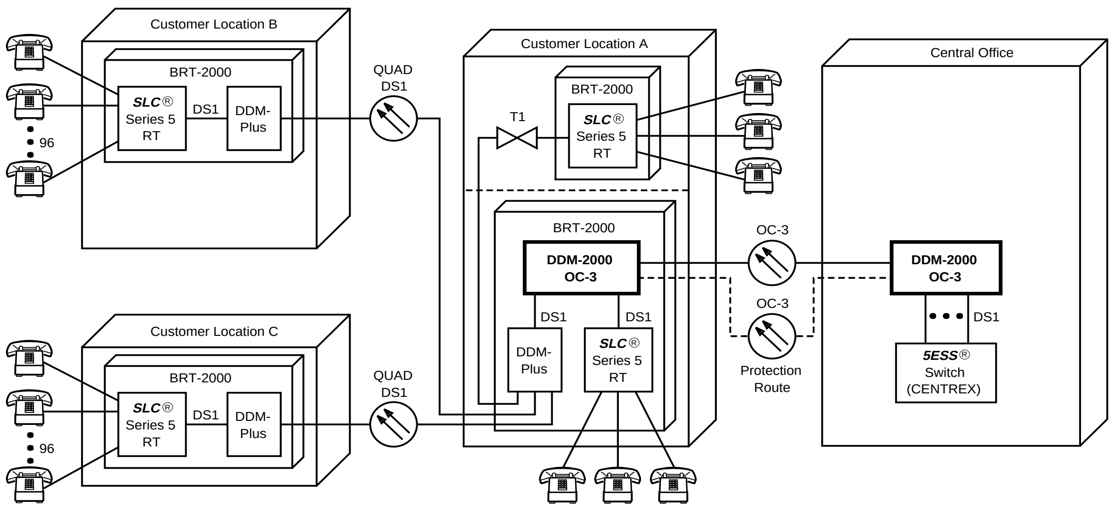

Figure 3-36. Campus CENTREX Configuration

The OC-3 point-to-point interoffice application (Figure 3-37) provides cost-effective DS1, DS3, EC-1, and OC-3c transport in outstate trunk routes that do not justify the expense of OC-12 and higher capacity systems. Just as in the OC-3 point-to-point loop application, the network consists of a pair of DDM-2000 OC-3 shelves configured as optical terminals.

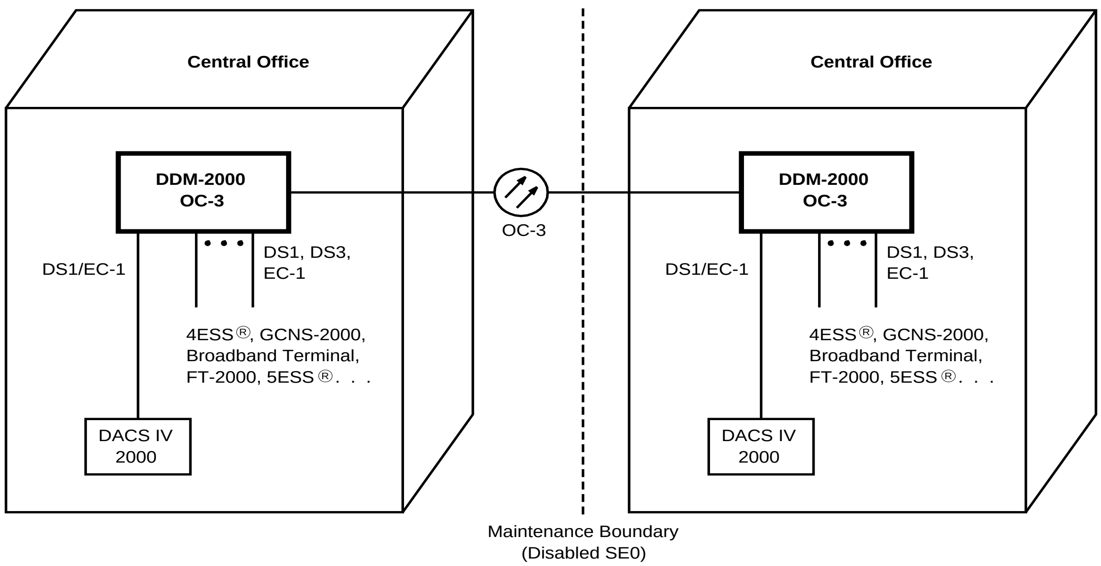

Figure 3-37. OC-3 Point-to-Point Interoffice Configuration

The DDM-2000 OC-3 Multiplexers allow independent synchronization of each site from its own office clock and have the ability to disable single-ended operations when the application crosses a maintenance boundary. Also, timing can be passed from one office clock to another with a DS1 timing output derived from an incoming OC-3 signal. The gigabit cell network switch (GCNS) in the figure is Lucent's asynchronous transfer mode (ATM) switch.

OC-12 Point-to-Point

Simple, efficient capacity upgrades provide an additional point of flexibility for the DDM-2000 OC-3 and OC-12 Multiplexers. Initial deployments can be sized according to current needs and near-term forecasts, which minimize the network's cost. As large-scale growth occurs (for example, DS1 and DS3 service expansion), the DDM-2000 OC-3 and OC-12 Multiplexers can be rearranged to match each application.

The upgrade from a DDM-2000 OC-3 point-to-point system to a DDM-2000 OC-12 system can be done without interrupting service. The procedure converts the DDM-2000 OC-3 Multiplexer shelves so that they interconnect with the DDM-2000 OC-12 Multiplexer shelf. The resulting high-capacity, point-to-point configuration is shown in Figure 3-38. The larger bandwidth accommodates additional DDM-2000 OC-3 Multiplexers for DS1 access.

In addition to upgrading an existing OC-3 network, the DDM-2000 OC-12 Multiplexer also provides DS3, EC-1, OC-3 or OC-3c service transport between a remote site and a CO. It can do this in either a stand-alone (terminal) configuration or, if desired, it could be connected directly to a DACS IV-2000 Cross-Connect System using DS3 or EC-1 interfaces.

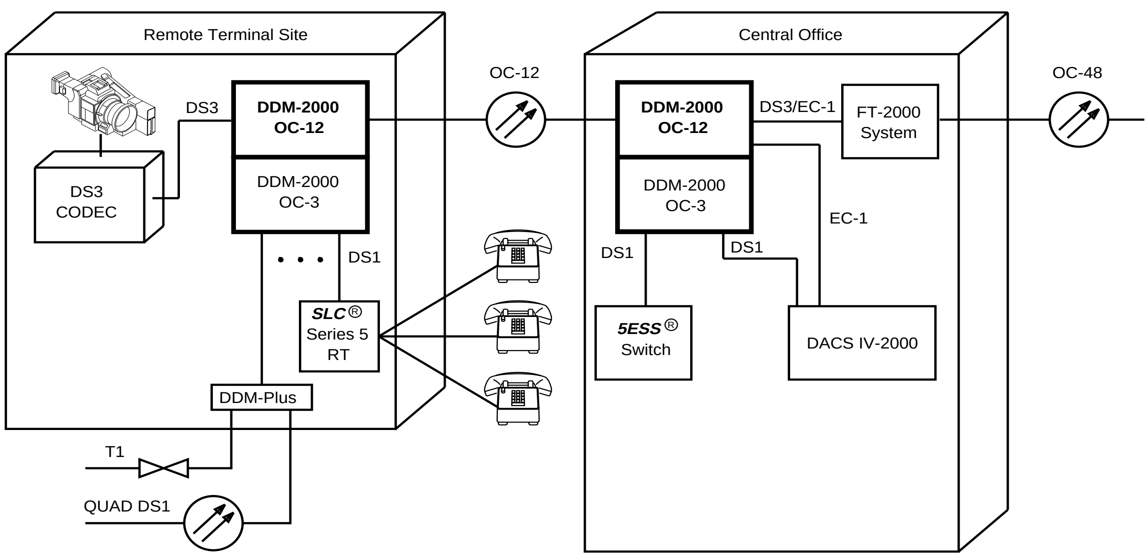

Figure 3-38. OC-12 Point-to-Point Loop Configuration

Like the loop feeder point-to-point applications, the interoffice DDM-2000 OC-3 point-to-point Multiplexer application supports smooth in-service capacity upgrades using the DDM-2000 OC-12 Multiplexer (Figure 3-39). The initial DDM-2000 OC-3 Multiplexer shelf is connected in service to the DDM-2000 OC-12 Multiplexer, allowing high-speed interconnection between offices. The DDM-2000 OC-12 Multiplexer is also well suited for stand-alone interoffice transport of high-capacity DS3, EC-1, and OC-3c signals. The DDM-2000 OC-12 Multiplexer offers two high-speed optical interfaces: at a wavelength of 1310 nm, it supports a 51 kilometer (32 miles) span length; and at a wavelength of 1550 nm, it supports a 100 kilometer (61 miles) span length.

Like the DDM-2000 OC-3 Multiplexers, the DDM-2000 OC-12 Multiplexers allow independent synchronization of each site from its own office clock and disabling single-ended operations when the application crosses a maintenance boundary. Timing can be passed from one office clock to another with a DS1 timing output derived from an incoming OC-12 signal.

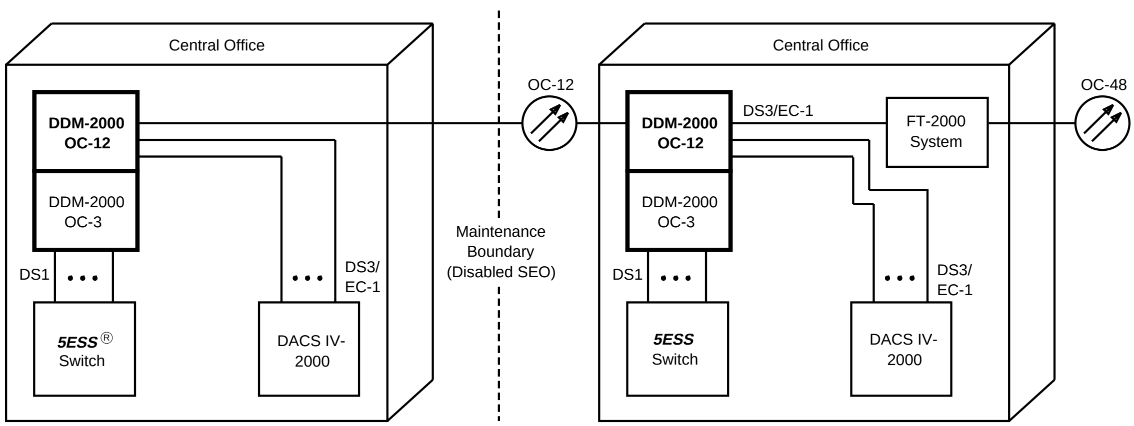

Figure 3-39. OC-12 Point-to-Point Interoffice Configuration

OC-3 Repeater

The DDM-2000 OC-3 Multiplexer supports single-mode fiber spans up to 55 kilometers (34 miles). For longer spans, the DDM-2000 OC-3 Multiplexer can be used in a repeater configuration shown in Figure 3-40. In this particular application of the STS-1 drop shelf configuration, all traffic passes between upstream and downstream OC-3 interfaces with no add/drop to/from low-speed interfaces.

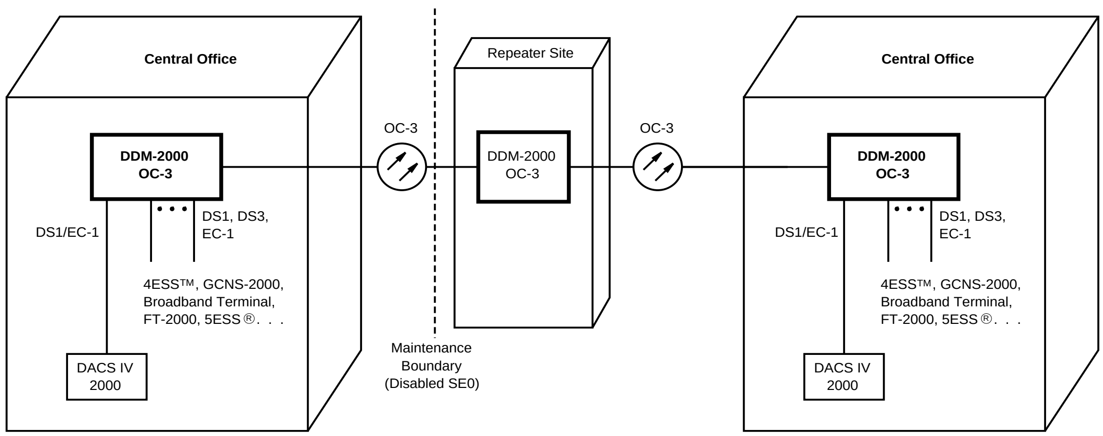

Figure 3-40. OC-3 Repeater Configuration

OC-12 Regenerator

The DDM-2000 OC-12 Regenerator is designed for applications that exceed the allowed loss budget of the DDM-2000 OC-12 Multiplexer. Such situations often occur in the loop feeder environment when diverse routing of service and protection lines causes one of the two routes, because of a combination of distance and connector/splice loss, to exceed the optical loss budget of the Multiplexer. A DDM-2000 OC-12 Regenerator can be used as a cost effective solution to this dilemma (Figure 3-41). The DDM-2000 OC-12 Regenerator may also be used symmetrically for applications requiring optical signal regeneration on both lines. Since the OC-12 Regenerator does not access the SONET DCC, OC-12 Regenerator software is compatible with all DDM-2000 OC-12 releases and can be used in all DDM-2000 OC-12 configurations.

To best serve loop feeder applications, the OC-12 Regenerator can be located at a remote site as well as in a CO. The DDM-2000 OC-12 Regenerator is through-timed (timing is recovered from the signal incoming to each regenerator and used to retime the outgoing signal) and therefore requires no external timing references at the regenerator site.

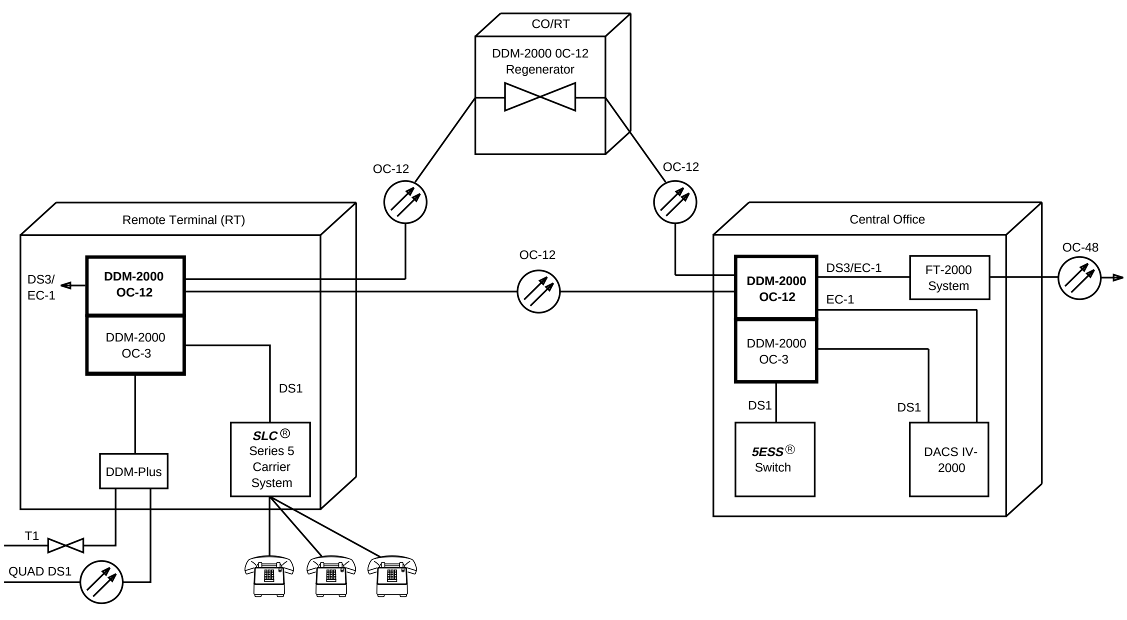

Figure 3-41. OC-12 Regenerator Loop Feeder Configuration (Diverse Routing)

Like the loop feeder application, the OC-12 Regenerator (Figure 3-42) supports interoffice applications that exceed the allowed loss budget of the DDM-2000 OC-12 Multiplexer. Diverse routing of the service and protection lines is supported in the balanced mode (the same number of regenerators on each line) or unbalanced mode (different numbers of regenerators on each line).

A single 14-inch OC-12 Regenerator shelf supports up to two bidirectional lines. These lines may be the service and protection lines of a single OC-12 system. Alternatively, one shelf can independently serve one bidirectional line each from two separate OC-12 systems. This allows two separate, diversely routed OC-12 systems to share the same regenerator shelf at the diversity point, reducing equipment cost.

If access to local traffic becomes necessary in the future, an OC-12 Regenerator in a diversely routed system can be upgraded in service to a ring node.

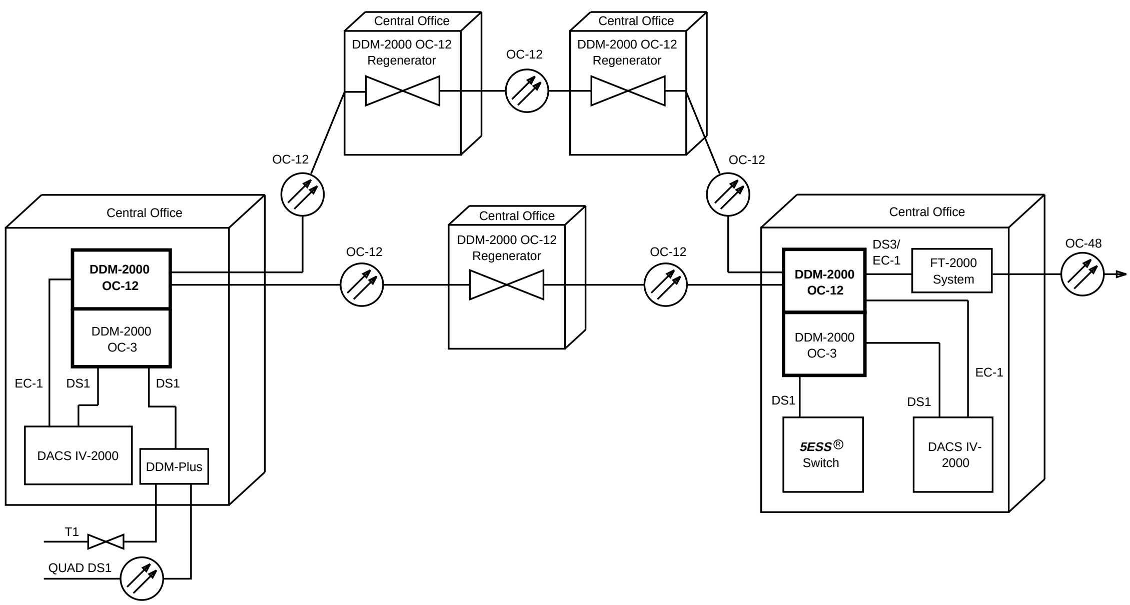

Figure 3-42. OC-12 Regenerator Interoffice Configuration (Diverse Routing)

Hubbing

As the sophistication of telecommunications users and services grows, so too will demands upon the network provider grow to supply more bandwidth at lower cost and in less time. The 2000 Product Family gives the network provider a competitive advantage through a new level of networking flexibility and efficiency. DDM-2000's add/drop and TSI capabilities are at the core of this advantage.

As an example, the DDM-2000 OC-3 system's TSI offers remotely programmable bandwidth management down to VT1.5 (DS1 payload) level. A network of DDM-2000 Multiplexers, each positioned near a growth area, provides a ready conduit for customer access to the network. The TSI gives each site access to the full network bandwidth as demand materializes, simplifying long-range network planning and improving ability in the face of changing service needs. Furthermore, remote control of time slot routing streamlines service provisioning and rearrangement and reduces technician activity at a remote site for each new work order.

The VT1.5 TSI in DDM-2000 OC-3 is coupled with the STS-1 TSI in DDM-2000 OC-12, the DS0 TSI in *SLC*-2000 Access System, and DACS IV-2000 to provide full-spectrum bandwidth management across networks of all sizes and configurations.

OC-3 Hubbing

Figure 3-43 and Figure 3-44 are examples of OC-3 hubbing configurations.

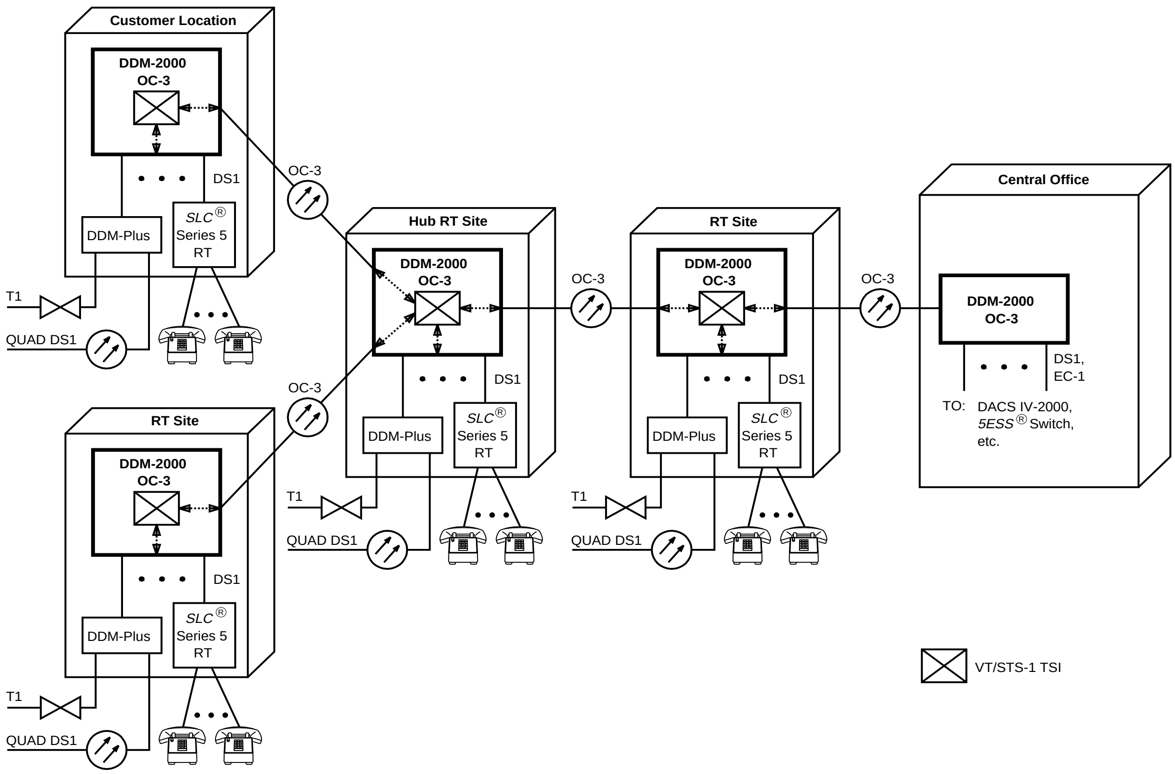

Figure 3-43. OC-3 Hubbing Configuration

A small industrial park, where each building uses more than a few DS1s, is shown in Figure 3-44. The higher bandwidth needs (for example, video) of some buildings suggest an OC-3 hubbing topology rather than quad DS1 optical extensions from a hub remote site. The hub may be in a customer location or a separate outdoor enclosure. From this hub site, OC-3 extensions feed business RT cabinets containing a DDM-2000 OC-3 Multiplexer in each building.

The flexible TSI capability of the DDM-2000 Multiplexers can be used to manage the changing bandwidths needs of the industrial park.

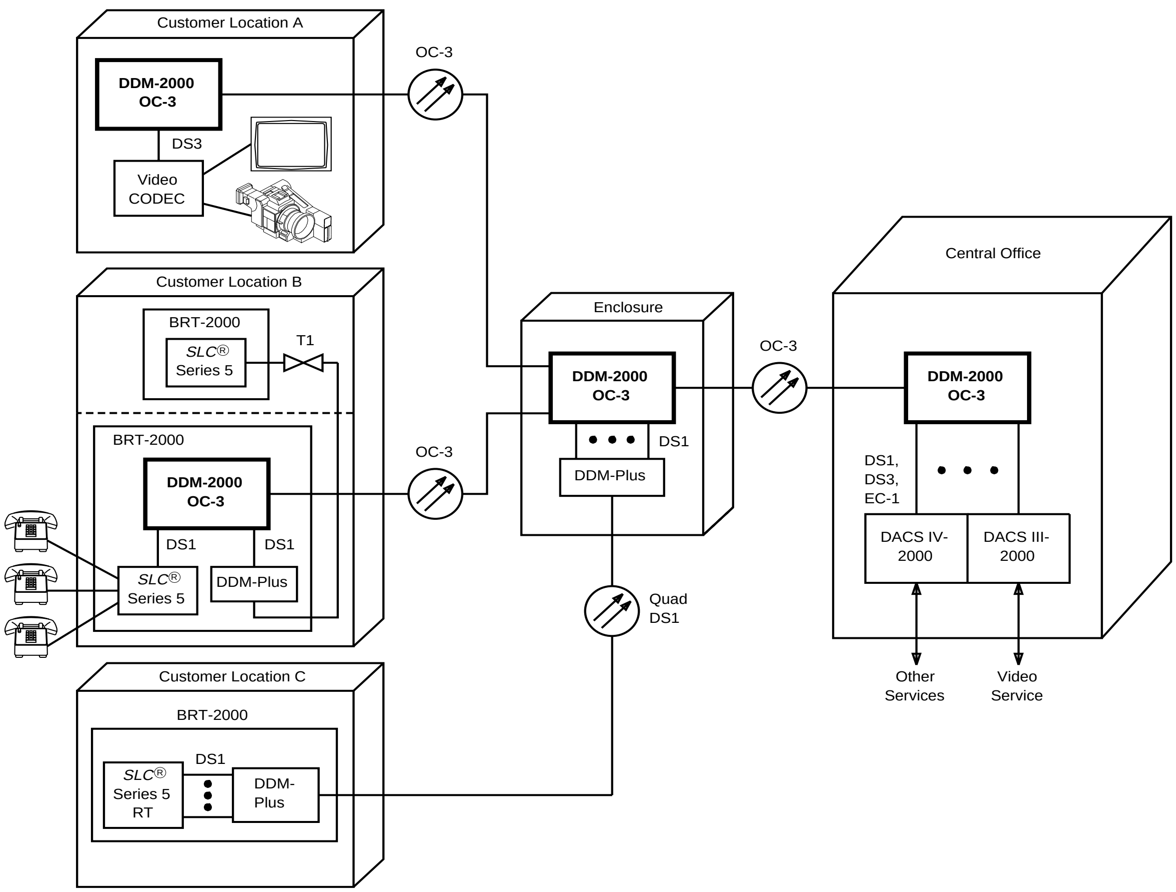

Figure 3-44. Small Industrial Park Configuration

OC-12 Hubbing

The DDM-2000 OC-12 Multiplexer supports the hubbing topologies that are often found in rural/suburban loop feeder environments. It can be used to provide OC-12 hubbing for an initial network installation or as an upgrade to a DDM-2000 OC-3 hubbing topology. The OC-3 hubbing application can grow to an OC-12 hubbing application (Figure 3-45) with a total network capacity of 12 STS-1s. This upgrade allows users to take advantage of the low-cost OC-3 hub initially and to use the high-capacity OC-12 hub when growth occurs at the RT sites.

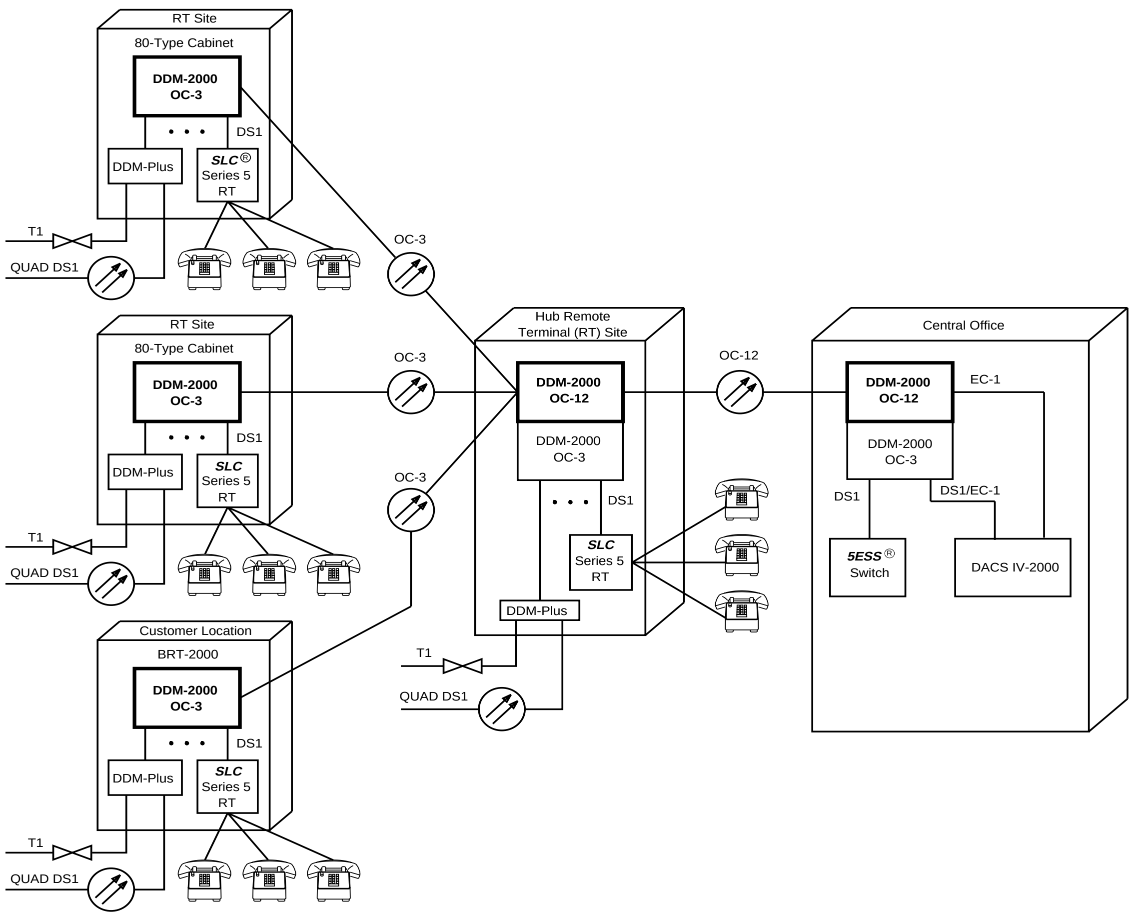

Figure 3-45. OC-12 Hubbing Configuration

The OC-12 hubbing application uses an OC-12 span between the CO and hub RT site. It retains the original OC-3 spans between the hub RT site and the end RT sites, allowing more total capacity to be allocated across the OC-3 optical extensions. For example, once the DDM-2000 OC-12 system is installed, the OC-3 optical extensions to the RT sites can grow to their full capacity of three STS-1 signals. The original DDM-2000 OC-3 Multiplexer at the hub RT site continues to serve local DS1 interface needs following the upgrade, while the OC-3 optical extensions are rolled to OC-3 low-speed interfaces on the DDM-2000 OC-12 Multiplexer. A maximum of four OC-3 spans may be extended from the OC-12 hubbing shelf. As in OC-12 point-to-point applications, growth beyond 84 DS1 signals may be met in the CO with additional DDM-2000 OC-3 Multiplexers or with DS3, EC-1, or OC-3 interfaces to a DACS IV-2000 Cross-Connect System or an FT-2000 OC-48 Lightwave System.

A large industrial complex with large bandwidth requirements equivalent to several STS-1 signals at each building requires an OC-12 hubbing topology. Such situations often arise at locations with high-density DS1 traffic and new DS3 services. The OC-12 hubbing application provides a flexible network solution to this application (Figure 3-46). The RT hub site can be located in a main building or centrally located in an outdoor enclosure.

The OC-12 capacity gives the planner many options to serve large collections of customers. Where DS3 services are needed (for example, for video), a BRT-2000 containing a DDM-2000 OC-3 Multiplexer should be installed adjacent to the DS3 terminal (for example, video codec). DS1 and voice-frequency service needs are also satisfied through other BRT-2000 configurations deployed as needed throughout the complex.

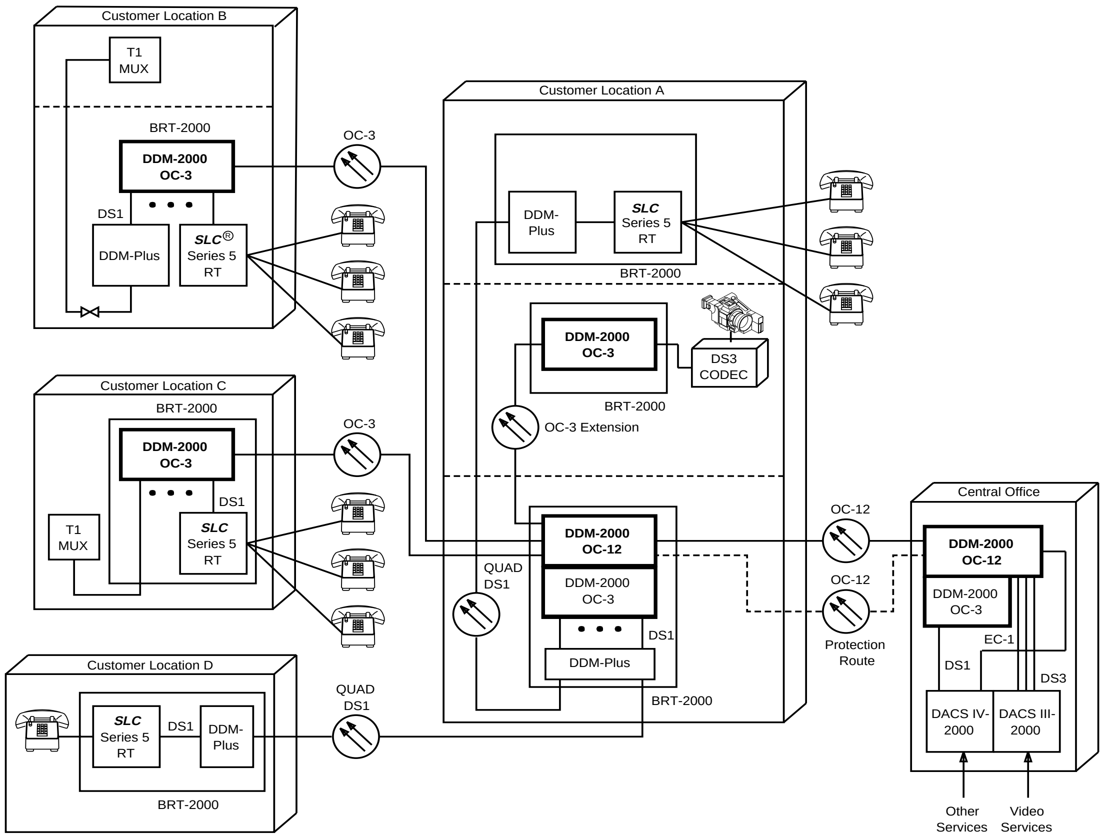

Figure 3-46. Large Industrial Park Configuration

OC-3c Transport on OC-12

To support the emerging market for ATM-based broadband services, the DDM-2000 OC-12 and OC-3 Multiplexers provide an OC-3c low-speed interface. Where broadband services are needed (for example, multimedia), a BRT-2000 with a DDM-2000 OC-12 or OC-3 Multiplexer should be installed near the broadband terminal to provide clear channel transport of the broadband service.

Many DDM-2000 features, such as high reliability, flexible networking configurations, and DS1/DS3/EC-1/OC-3c services, satisfy private network needs. Figure 3-47 shows how DDM-2000 OC-3 and OC-12 Multiplexers provide flexible interconnection of several data/video networks. The two multibuilding campuses have local data needs served by ATM networks.

Video conferencing between the campuses and data traffic between the ATM networks are transported via DDM-2000 OC-12 Multiplexers with some data traffic being extended via the hubbing feature to a remote location served by a DDM-2000 OC-3 Multiplexer. The physical facility, in this case, may be dark (installed but not being used) fiber leased from a local operating company.

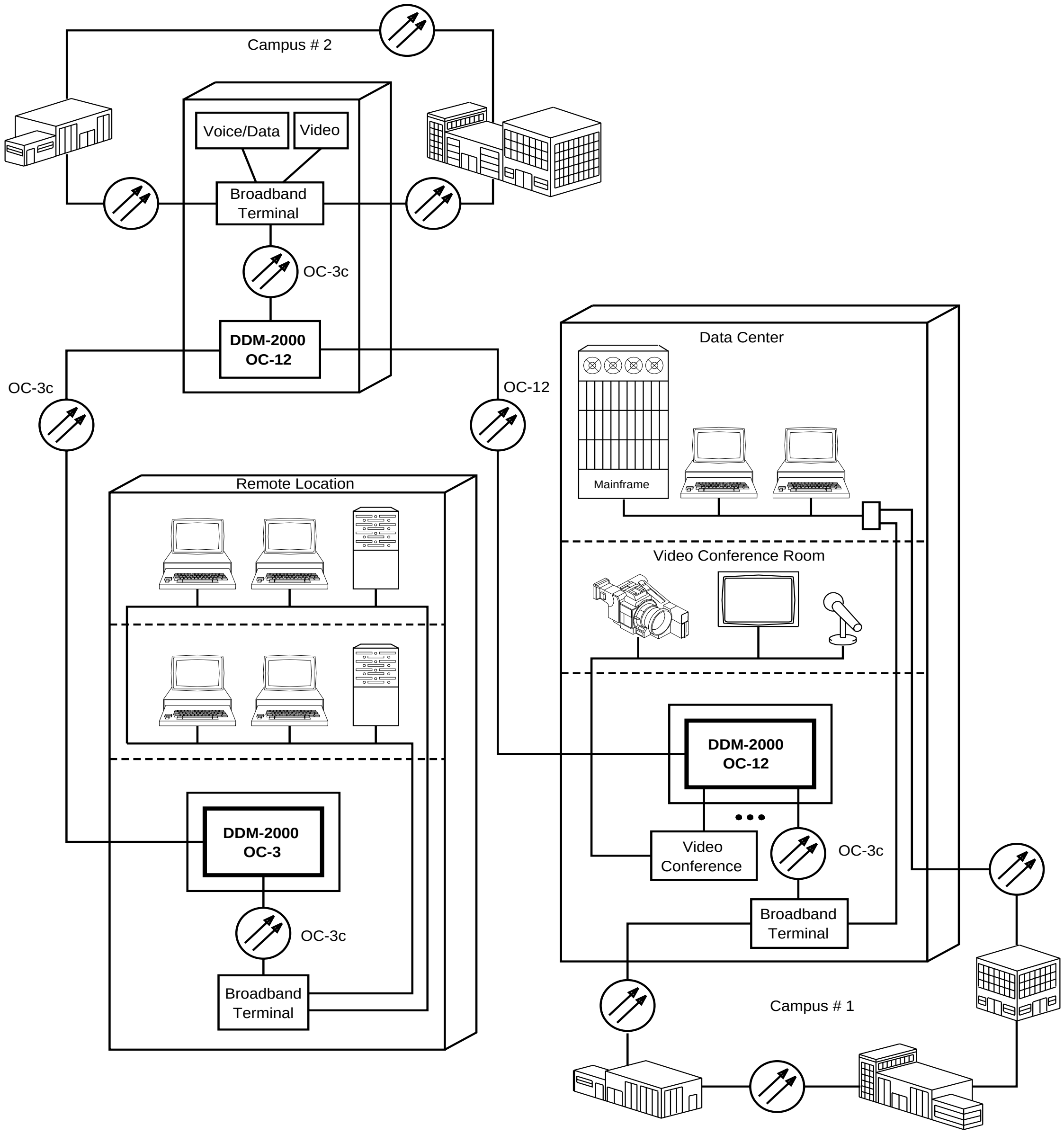

Figure 3-47. OC-3c Transport— Private Data/Video/ATM Network Application

Add/Drop

The DS1 add/drop loop application allows several remote sites to share a common OC-3 facility to the CO. The programmable TSI allows individual DS1 and DS3 services to be routed under local or remote software control. Remote control of time slot routing streamlines service provisioning and rearrangement, reducing technician activity at the remote site for each new work order.

The TSI feature offers full flexibility in assigning signals between low-speed DS1 or DS3 ports and any high-speed time slot. Additionally, the TSI can groom pass-through VT1.5 and STS-1 tributaries to simplify network planning and maximize utilization. The VT1.5/STS-1 TSI capability in the DDM-2000 OC-3 Multiplexer is coupled with an STS-1 TSI in the DDM-2000 OC-12 Multiplexer to provide flexible bandwidth management through the network's long-term evolution.

DDM-2000 OC-3 and OC-12 Multiplexers configured in add/drop topologies can route traffic between a CO site and a set of RT sites, between RT sites, or a mix of both traffic patterns. An initial add/drop network may start with OC-3 facilities, satisfying preliminary demand forecasts with minimum cost. Depending on the route's layout, existing cables and rights-of-way, and other planning concerns, the add/drop network may be arranged in a linear fashion (Figure 3-48). This flexibility in configuration allows the DDM-2000 network to be customized for each specific situation.

The tributary grooming provided by the TSI is especially useful at a hub RT location. At the hub RT site, the TSI sheds unused bandwidth on the OC-3 extensions and packs time slots carrying active service from remote sites onto the high-speed interface back to the CO. This maximizes utilization of existing equipment and facilities.

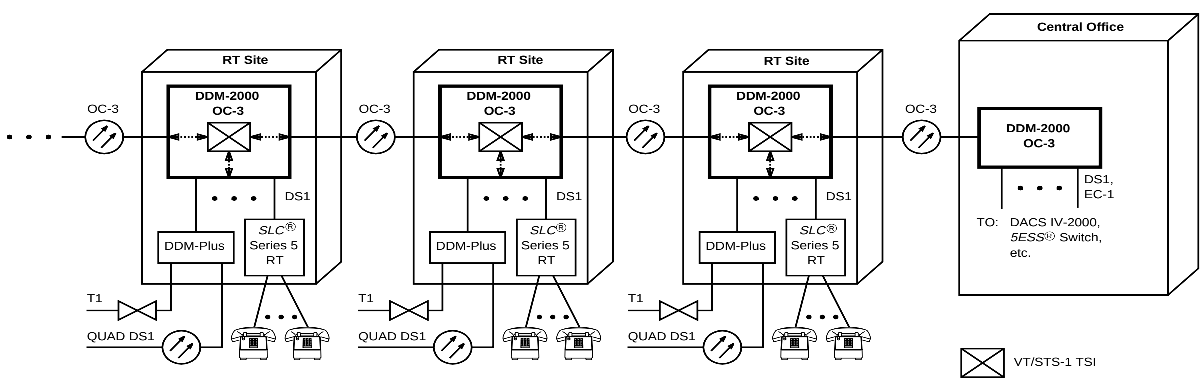

Figure 3-48. DS1 Add/Drop — OC-3 Linear Configuration

The OC-3 DS1 add/drop application (Figure 3-49) provides an extremely flexible, cost-effective solution to small or medium cross-section interoffice networks such as outstate trunks. Low-density routes that primarily transport DS1 traffic are ideally suited to the DDM-2000 OC-3 Multiplexer's capacity, where the capability to add and drop single DS1 tributaries maximizes network utilization and planning flexibility.

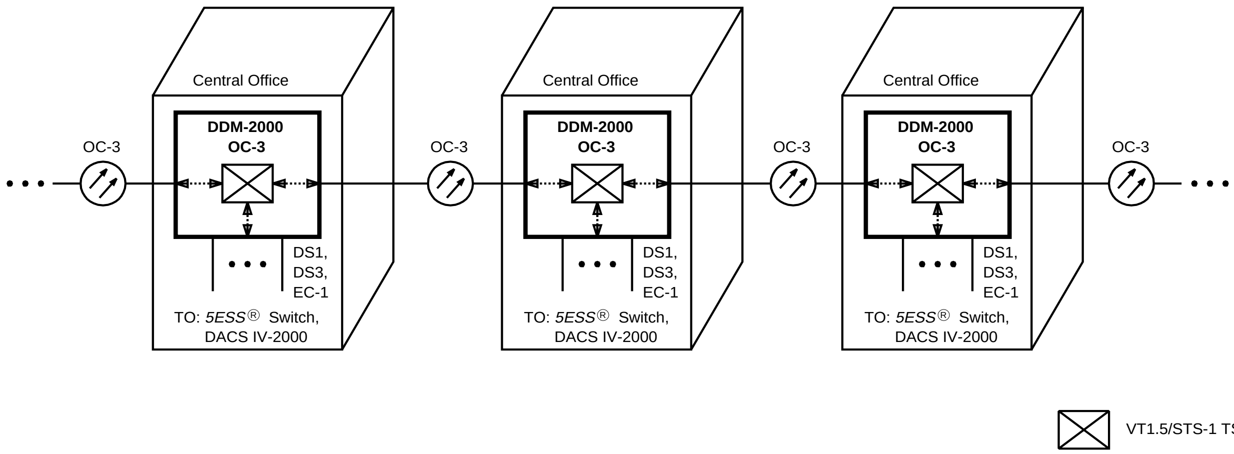

Figure 3-49. DS1 Add/Drop — OC-3 Interoffice Configuration

Electrical Multiplexer

The DDM-2000 OC-3 Multiplexer can be configured as an electrical multiplexer for SONET interoffice networks. The electrical multiplexer configuration is optimized for interworking with other SONET products. With its SONET standard EC-1 interfaces, the electrical Multiplexer configuration can also be installed in an unconstrained mixed-vendor environment.

The electrical multiplexer configuration, Figure 3-50, operates as three independent multiplexers, each creating a VT-formatted STS-1 from 28 DS1 low-speed interfaces. Traffic from each one of these electrical multiplexers can be carried over any SONET transmission network and can be terminated on any VT1.5-based SONET NE at the other end of the network. These include other DDM-2000 OC-3 Multiplexers and/or DACS IV-2000 Cross-Connect Systems.

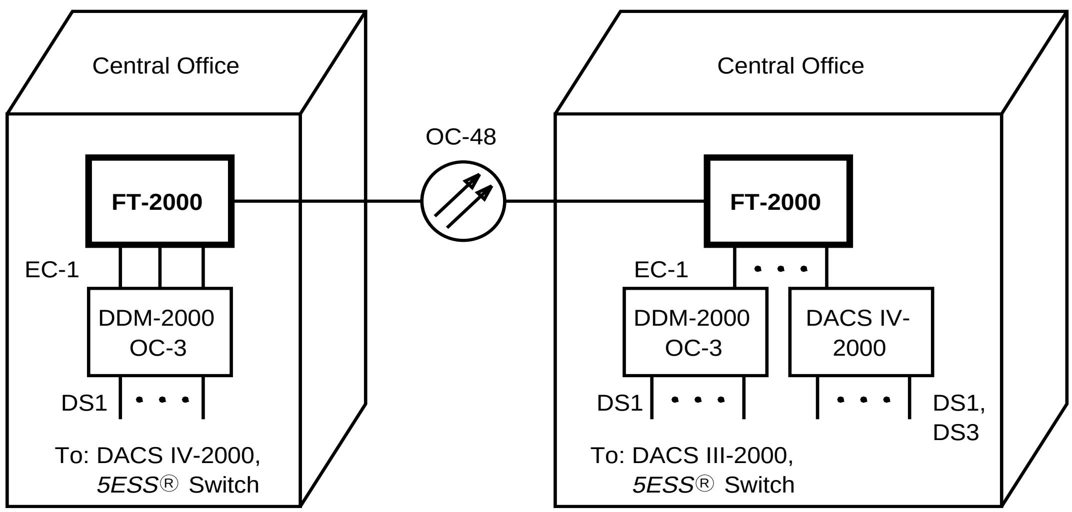

Figure 3-50. DDM-2000 OC-3 Electrical Multiplexer Configuration

Lucent 2000 Product Family Interworking

SLC-2000 Access System

The *SLC*-2000 Access System is Lucent's next generation digital loop carrier (DLC) system. The *SLC*-2000 Access System can be installed in any existing pair gain application, providing telephone service, integrated services digital network (ISDN) capability, DS1 pipes, and special services. Full DS0 bandwidth management capabilities (based on Telcordia Technologies TR-303) provide for more efficient and flexible network growth.

Figure 3-51 shows a business narrowband application using the DDM-2000 FiberReach Multiplexer on an OC-1 path switched ring. This application provides protected POTS, ISDN, and special services, as well as DS1 services. The ring host is a DDM-2000 OC-3/OC-12 remote node on an OC-3/OC-12 path switched ring via a *SLC*-2000 ARM or a DDM-2000 OC-3 Multiplexer.

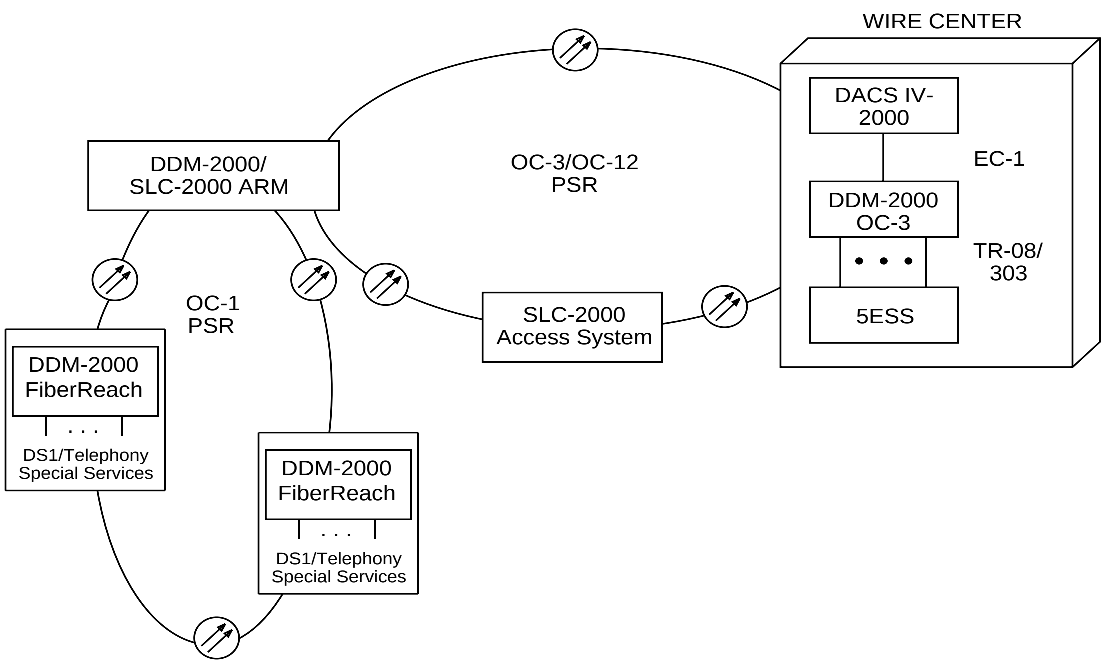

Figure 3-51. OC-3 Loop Carrier Interface Configuration

At hubbing and linear add/drop sites, a DDM-2000 Multiplexer and *SLC*-2000 Access System RT combine to create an integrated SONET DLC node. The DDM-2000 Multiplexer provides the OC-3 and OC-12 facility interfaces and add and drop traffic to the adjacent *SLC*-2000 Access System RT via EC-1 or IS-3 interfaces. Figure 3-52 shows *SLC*-2000 Access System in an OC-12 hubbing application. A DDM-2000 OC-3 Multiplexer is used at one of the RT sites due to demand for more than 28 DS1 services.

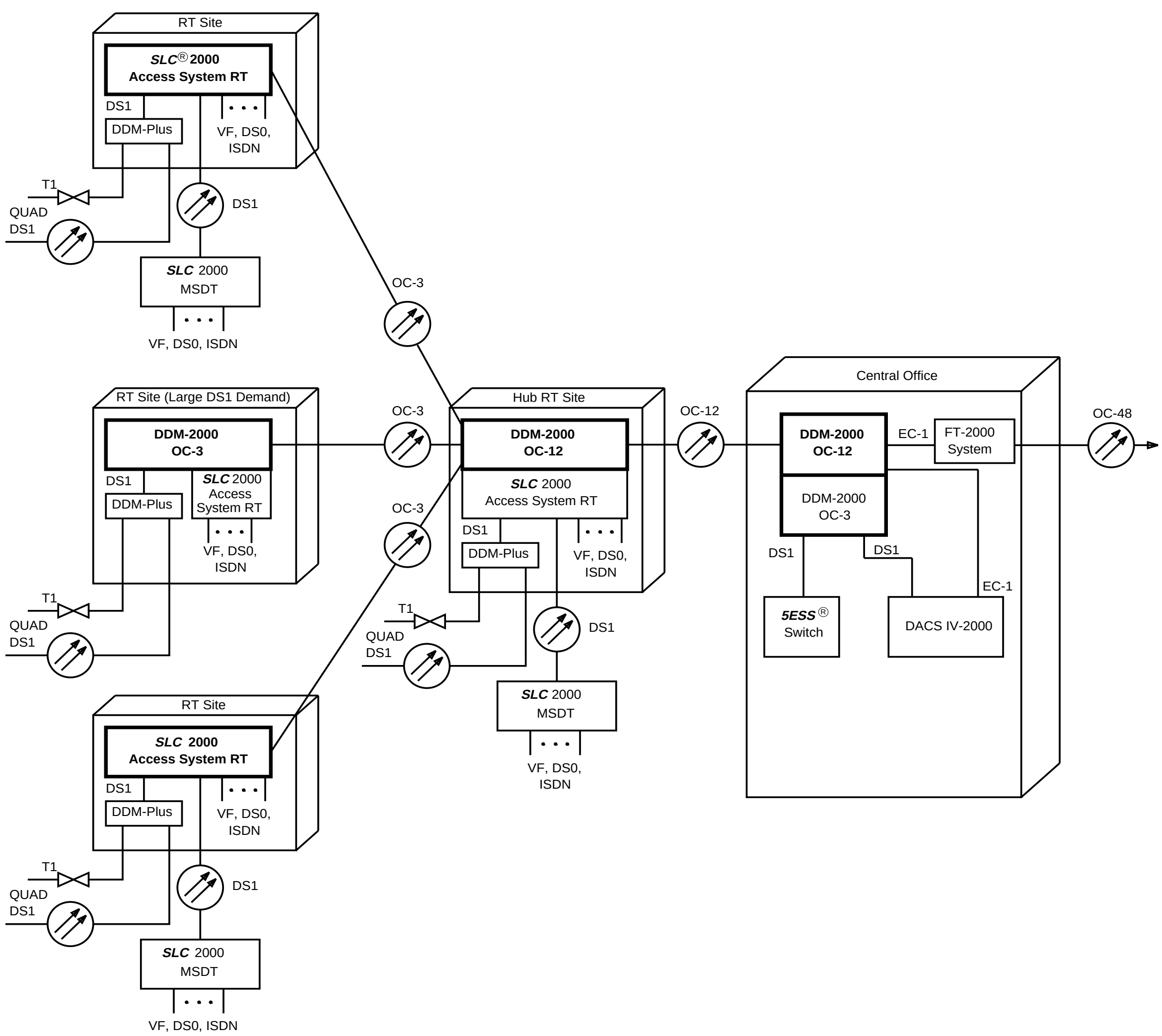

Figure 3-52. SLC-2000 Access System in an OC-12 Hubbing Configuration

DACS IV-2000 Cross-Connect System

The DACS IV-2000 can serve as the CO core of a highly flexible and efficient transmission network. A centrally located complex of DACS III-2000 and DACS IV-2000 positions the network to deliver new services more quickly and at a lower cost. DACS IV-2000 is particularly suited for access network integration with its DS1/VT1.5 and DS3/STS-1 cross-connect features.

As shown in Figure 3-53, the DDM-2000 access network will interface with a DDM-2000 CO shelf to terminate the fiber and perform OAM&P functions. EC-1 electrical interfaces to DACS IV-2000 will maintain STS-1 and VT1.5 SONET path connectivity (providing, for example, performance monitoring) and allow DACS IV-2000 to perform cross-connections on SONET STS-1 and VT tributaries.

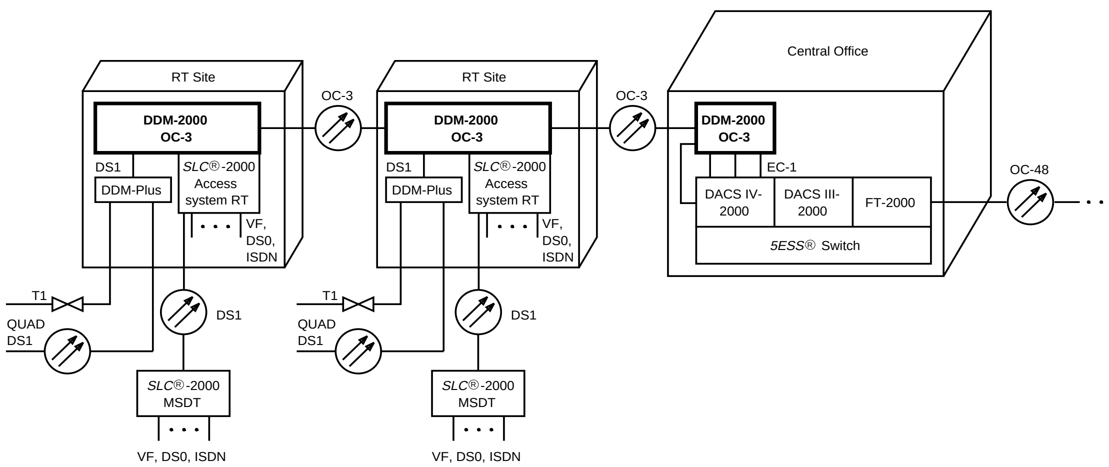

Figure 3-53. DACS IV-2000 Access Configuration

Beginning with DACS IV-2000 Release 5, an Integrated Operations Controller (IOC) is now available to combine the DACS IV-2000 and DDM-2000 SONET technologies. This IOC can manage the DACS IV-2000 with optical bays, consisting of DDM-2000 OC-3 and/or OC-12, merging the control of both network elements under an integrated interface. It provides the full range of circuit management and alarm surveillance spanning these network elements.

FT-2000 OC-48 Lightwave System

Operations interworking (OI)* provides the capability to access, operate, provision, and administer remote Lucent SONET NEs from any location in a SONET subnetwork or from a centralized OS.

OI is available among Lucent 2000 Product Family systems connected through the SONET DCC including:

- FT-2000 OC-48 Lightwave System (Release 6.0 and later)
- DDM-2000 OC-3 Multiplexer (Release 7.2 and later)
- DDM-2000 OC-12 Multiplexer (Release 5.0 and later)
- DDM-2000 FiberReach Multiplexer (Release 2.1 and later)

The FT-2000 OC-48 Lightwave System equipped with Release 6.0.0 software supports OI applications with DDM-2000 OC-3 Multiplexers (Figure 3-54).

Messages carried on the SONET section DCC support the following interworking applications:

- Remote login
- Gateway network element (GNE) operation
- Remote network element status
- Remote software download and copy.
- **Remote login**: A user logged in locally to an FT-2000 OC-48 Lightwave System can remotely log in to a DDM-2000 OC-3 Multiplexer via the OC-3 DCC. However, a user logged in locally to a DDM-2000 OC-3 Multiplexer can not remotely log in to the FT-2000 OC-48 Lightwave System. A user logged in locally to a DDM-2000 OC-3 Multiplexer can remotely log in to another DDM-2000 OC-3 Multiplexer through an FT-2000 OC-48 Lightwave System.
- **Gateway network element operation**: One or more FT-2000 OC-48 Lightwave Systems can serve as a single interface to the local X.25 message-based operations system for the DDM-2000 OC-3 Multiplexers through the OC-3 DCC. The GNE also serves as a single interface for all FT-2000 OC-48 Lightwave Systems in the same ring network and in the same subnetwork. In a mixed DDM-2000 OC-3/FT-2000 OC-48 Lightwave System network, the FT-2000 OC-48 Lightwave System must serve as the GNE(s). Multiple GNEs are supported in a DDM-2000 OC-3 network.

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* The introduction of Target ID Address Resolution Protocol (TARP) for OI in DDM-2000 OC-3 Release 13.0, 15.0, and OC-12 Release 7.0 will effect the operations of some features of OI. Refer to Section 5, “Operations, Administration, Maintenance, and Provisioning,” for more information.

- **Remote network element status**: The FT-2000 OC-48 Lightwave System can receive and transport alarm and status information from other FT-2000 OC-48 Lightwave Systems and DDM-2000 OC-3 Multiplexers that are in the same subnetwork. Within a subnetwork, NEs in the same alarm group (provisionable) exchange alarm and status information through at least one alarm gateway network element (AGNE). When an AGNE receives alarm and status information, it rebroadcasts the information to all the other NEs in the alarm group. An alarm group can support the maximum number of NEs supported in the subnetwork.

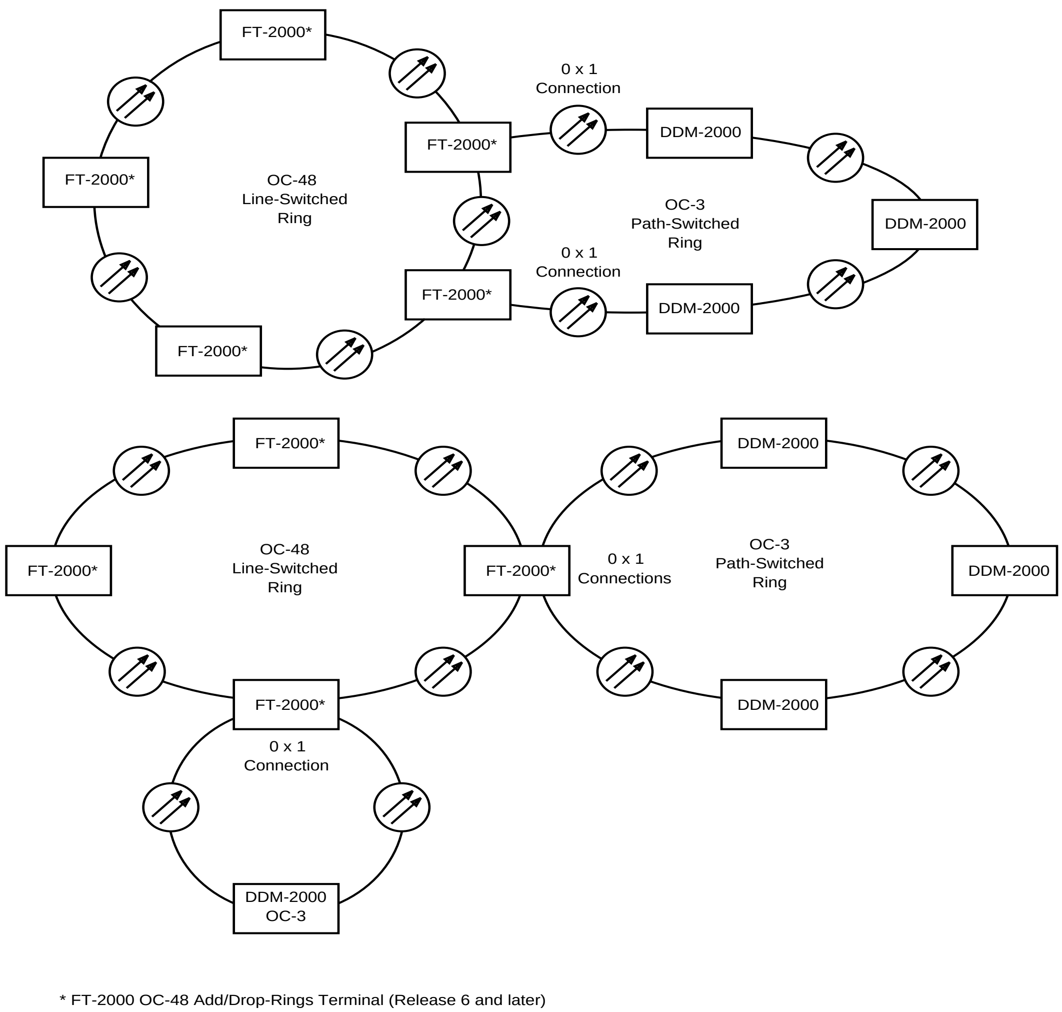

Figure 3-54. Operations Interworking Application

- **Remote software download and copy**: An FT-2000 OC-48 Lightwave System can download (copy) software to remote FT-2000 OC-48 Lightwave Systems in the same subnetwork and across a DDM-2000 OC-3 network to another FT-2000 OC-48 Lightwave System in the same subnetwork. Similarly, a DDM-2000 OC-3 Multiplexer can download (copy) to another DDM-2000 OC-3 through an FT-2000 OC-48 Lightwave System in the same subnetwork.

Figure 3-55 shows two types of OC-3 interface connections between FT-2000 OC-48 Lightwave System line switched rings and DDM-2000 OC-3 path switched rings.

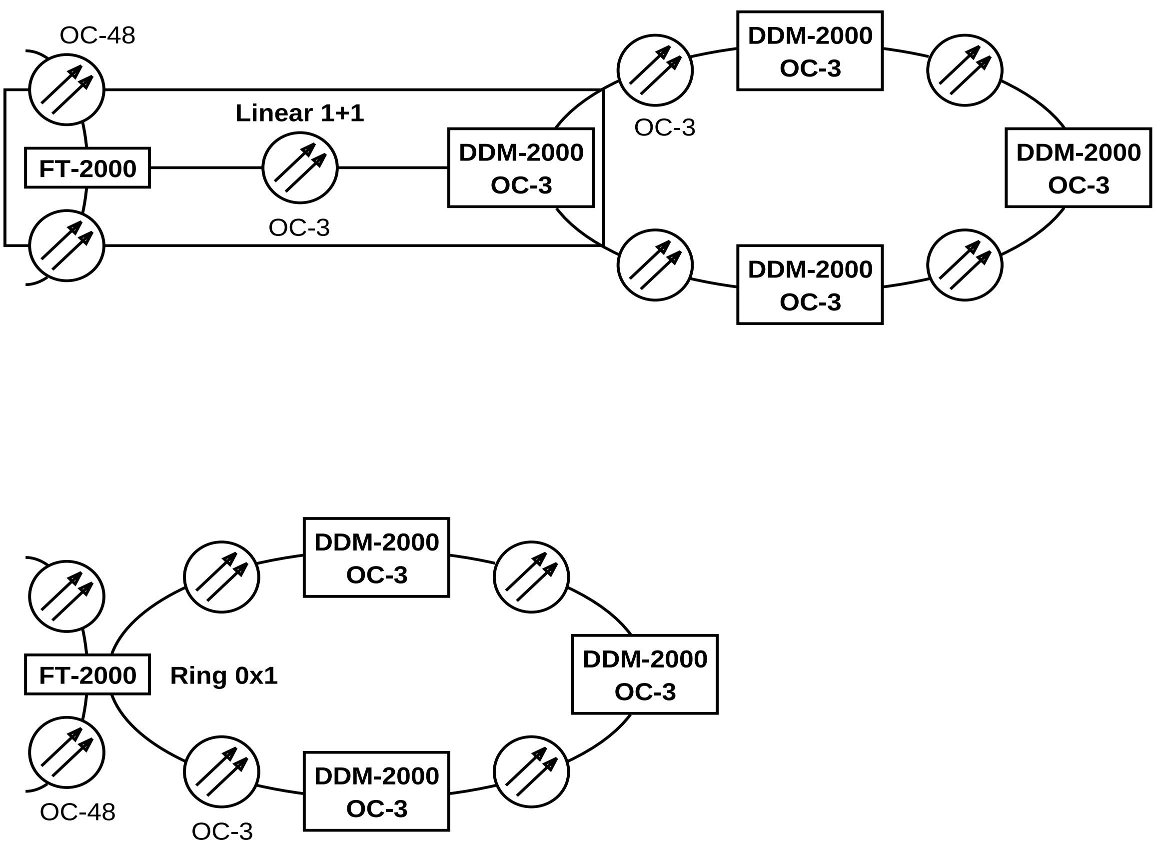

Figure 3-55. OC-3 Ring Interfaces with FT-2000 OC-48 Lightwave System

- Linear (1+1). In this configuration (top figure of Figure 3-55), there is a 1+1 OC-3 interface connection to an FT-2000 OC-48 Lightwave System NE. A failure of the 1+1 OC-3 interface will trigger a DDM-2000 OC-3 line protection switch. Figure 3-56 shows a major application of this feature in a DRI application using optical OC-3/IS-3 interfaces.
- Ring (0x1). In this configuration (bottom figure of Figure 3-55), there are two 0x1 OC-3 interface connections to one FT-2000 OC-48 Lightwave System NE. A failure of one of the 0x1 OC-3 interfaces will trigger a DDM-2000 OC-3 path protection switch.

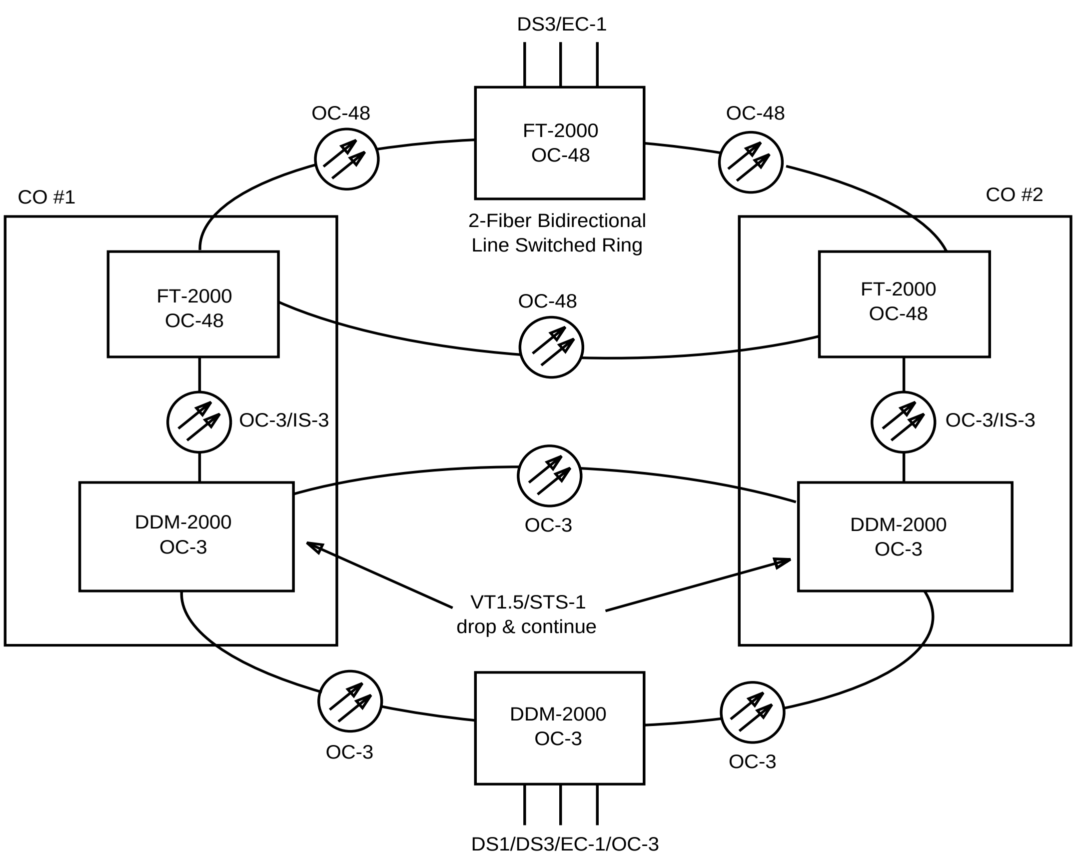

Figure 3-56. DDM-2000 OC-3 to FT-2000 OC-48 Lightwave System Dual Ring Interface

Figure 3-57 and Figure 3-58 show other examples of interfaces between FT-2000 OC-48 Lightwave System and OC-3 linear and OC-12 ring systems.

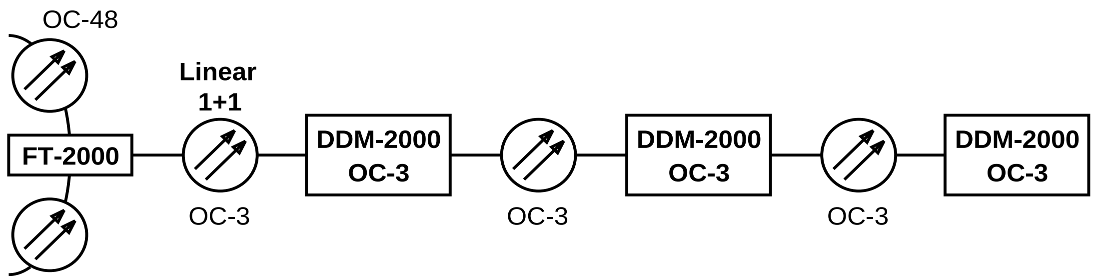

Figure 3-57. OC-3 Linear Interfaces with FT-2000 OC-48 Lightwave System

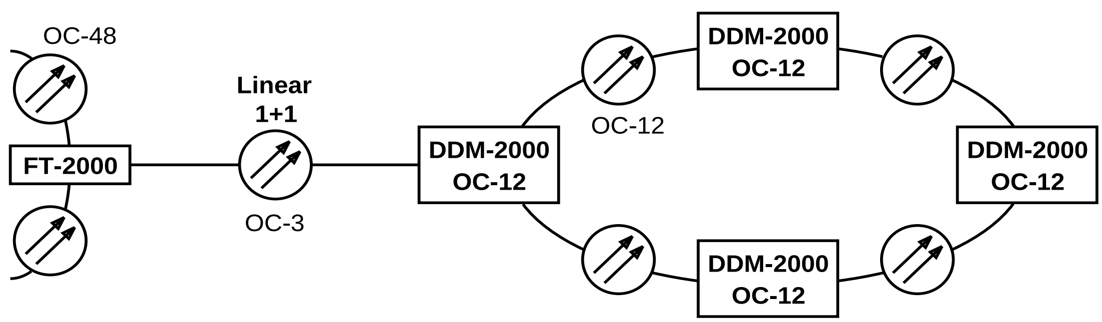

Figure 3-58. OC-12 Ring Interfaces with FT-2000 OC-48 Lightwave System

MegaStar 2000 Radio

These configurations (linear and ring) are part of the Lucent Technologies and Harris-Farinon *MegaStar* 2000 Radio system supporting mixed fiber and radio topologies. Figure 3-59(a.) shows a linear topology while Figure 3-59(b.) shows a ring topology.

These configurations feature:

- Hybrid fiber and microwave architecture
- DCC connectivity across the microwave span
- Similar OAM&P as DDM-2000 OC-3 Multiplexer linear and ring networks.

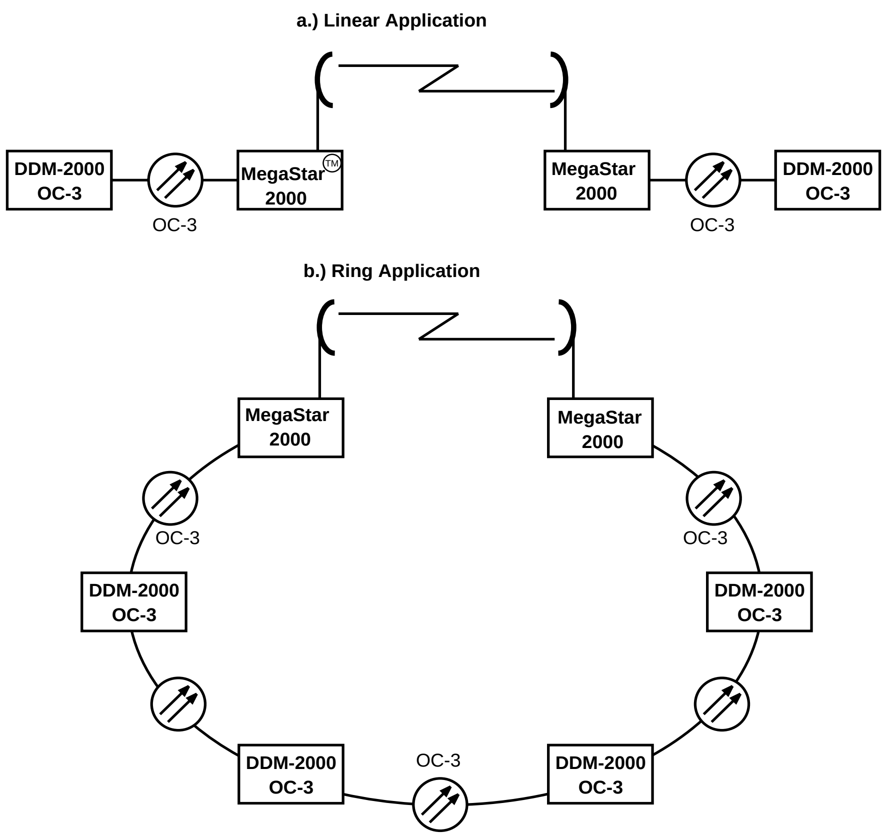

Figure 3-59. MegaStar 2000 Radio Support Using DDM-2000 OC-3 Multiplexers

Multi-Vendor OI Applications

Figure 3-60 shows a multivendor application partnering Lucent's DDM-2000 and FT-2000 with Tellabs *TITAN*[*] *5500* DCS. This OI, based on SONET standards, allows service providers to offer more flexible services to generate revenues and improve overall network maintenance efficiency.

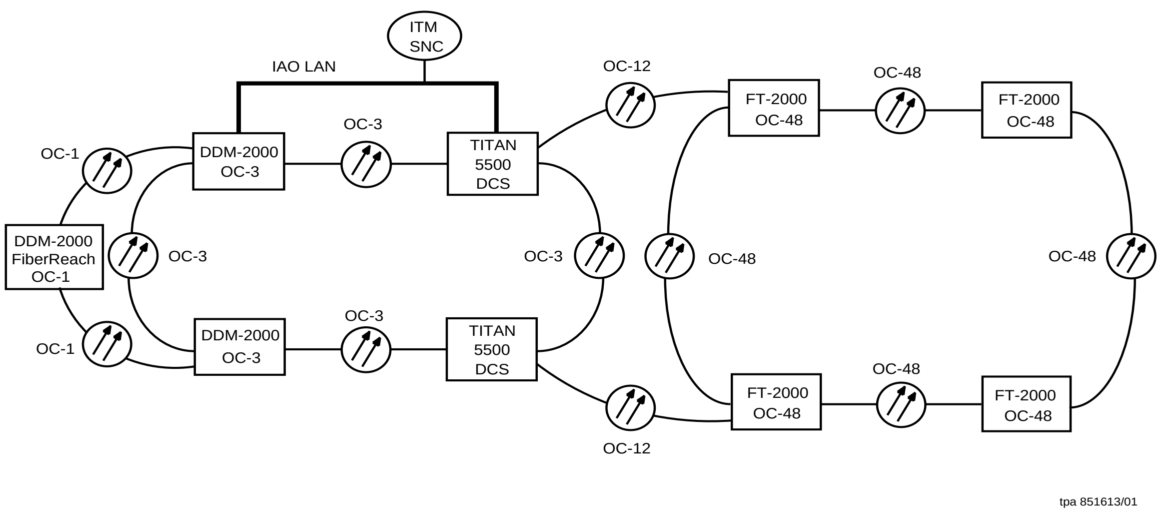

Figure 3-60. Interworking of OC-1/OC-3/OC-12/OC-48 with Tellabs TITAN 5500 DCS

* *TITAN* is a trademark of Tellabs, Inc.

Multi-Product OI Applications

WaveStar BWM, WaveStar 2.5G, and WaveStar 10G also support TARP, OSI, and TL1/X.25. Therefore, compatibility between PF-2000 and WaveStar allows for "multiproduct" OI.

Of the PF-2000 TARP Releases that support OI with WaveStar BWM 2.5G/10G, only DDM-2000 OC-3 R15 supports *high*-speed OC-3 (or OC-12) *linear* (1+1) interfaces. However, applications that require a DDM-2000 OC-3 shelf to multiplex low-speed DS1 traffic onto an OC-3 (or OC-12) interface are still supported as shown in Figure 3-61.

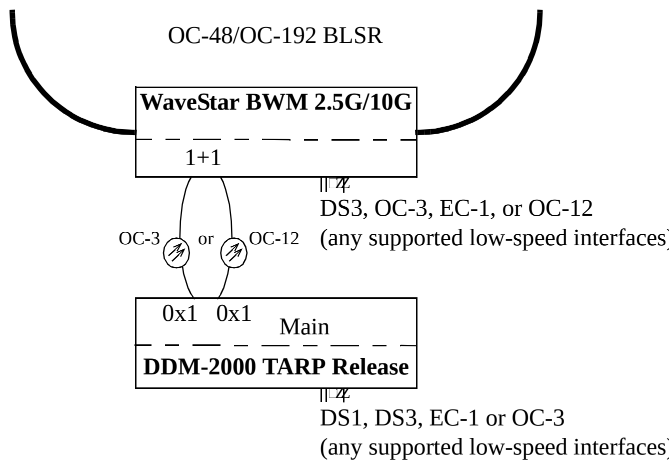

Figure 3-61. DDM-2000 to WaveStar Connectivity

NOTE:
This application is *neither* path-on-line applications *nor* WaveStar BWM 2.5G/10G Unidirectional Path-Switched Ring (UPSR) termination. WaveStar BWM 2.5G/10G supports path-on-line applications.

In the subject application, DDM-2000 operates as a UPSR ring node, with low-speed DS1 (or DS3 or EC1 or OC-3) interfaces and dual 0x1 high-speed OC-3 (or OC-12) ring interfaces. The DDM-2000 dual 0x1 OC-3 (or OC-12) fiber pairs are connected to WaveStar BWM 2.5G/10G, but those WaveStar BWM 2.5G/10G ports are provisioned as a linear (1+1) protection group. The STS-1 paths on such linear (1+1) interfaces can be cross-connected to any other port (OC-48, OC-12, OC-3, EC-1, or DS3) on the WaveStar BWM 2.5G/10G.

NOTE:
Multiple DDM-2000s can be connected to a WaveStar BWM 2.5G/10G in this same way, but each DDM-2000 must be in its own separate *single*-node UPSR for this application.

Service Applications

Loop Feeder

The DDM-2000 Multiplexers provide a full set of interfaces, topologies, operations and upgradability to provide the flexibility and ease of operation required to meet the dynamic requirements of the loop feeder environment.

The DDM-2000 Multiplexers are particularly suited to the evolving needs of loop feeder applications. They offer many essential features: compact size, environmental hardening, single-ended operations, and capacity and topology upgrades. The DDM-2000 Multiplexers' extensive set of topologies allows the network to be optimized for a particular route geography, service mix, and growth forecast. See Figure 3-33 and Figure 3-38 for loop feeder examples.

Interoffice Transport

The DDM-2000 Multiplexers provide the features necessary for interoffice transport applications. Examples include long span optics, OC-12 regenerators, easy capacity upgrades, and full DS1 and DS3 add/drop capability. Interoffice applications include point-to-point, stand-alone SONET electrical multiplexing, add/drop, path switched ring, and DRI.

The DDM-2000 OC-3 and OC-12 Multiplexers provide the following features for interoffice applications:

- DS1 transport
- DS3 transport
- EC-1 transport
- OC-3c transport
- Synchronization distribution
- Single-ended or independent operations
- Single-mode fiber spans up to 55 kilometers (34 miles) for OC-3, up to 51 kilometers (32 miles) for OC-12 at a wavelength of 1310 nm, and up to 100 kilometers (61 miles) for OC-12 at a wavelength of 1550 nm.

A VT1.5/STS-1 path switched OC-3 ring is a very effective self-healing network configuration for small cross-section interoffice networks, such as outstate trunks.

Any number of nodes in a DDM-2000 interoffice network can be independently synchronized from a BITS clock. Timing inputs can also be provided to the BITS from a DDM-2000 OC-3 or OC-12 Multiplexer using the DS1 timing output feature. See Figure 3-37, Figure 3-39, Figure 3-40, and Figure 3-41 for examples.

Broadband Business Access

New telecommunications needs for customer networks include higher bandwidth services based on DS1, DS3, and STS-3c rates; a self-healing capability for businesses most sensitive to service disruption; and rapid service deployment and rearrangement to keep pace with a changing environment. The flexible, advanced capabilities of the DDM-2000 OC-3 and OC-12 Multiplexers create a powerful platform along with other Lucent 2000 Product Family systems to keep pace with these dynamic customer needs.

The more a business relies on telecommunications, the more important self-healing networks become. In particular, finance, medical, transportation, education, and government users are insisting on a highly reliable network. These users are also driving for higher bandwidth data and video services.

The large multisite medical facility shown in Figure 3-62 uses broadband services for intersite imaging and video needs as well as lower bandwidth voice and data services into the public network based in ISDN primary rate interface (PRI) and basic rate interface (BRI) interfaces. These services can be delivered efficiently with the DDM-2000 OC-3, OC-12, and *SLC*-2000 Access System's flexible TSI and add/drop capabilities. The ring architecture prevents service outage due to a cable cut or node failure.

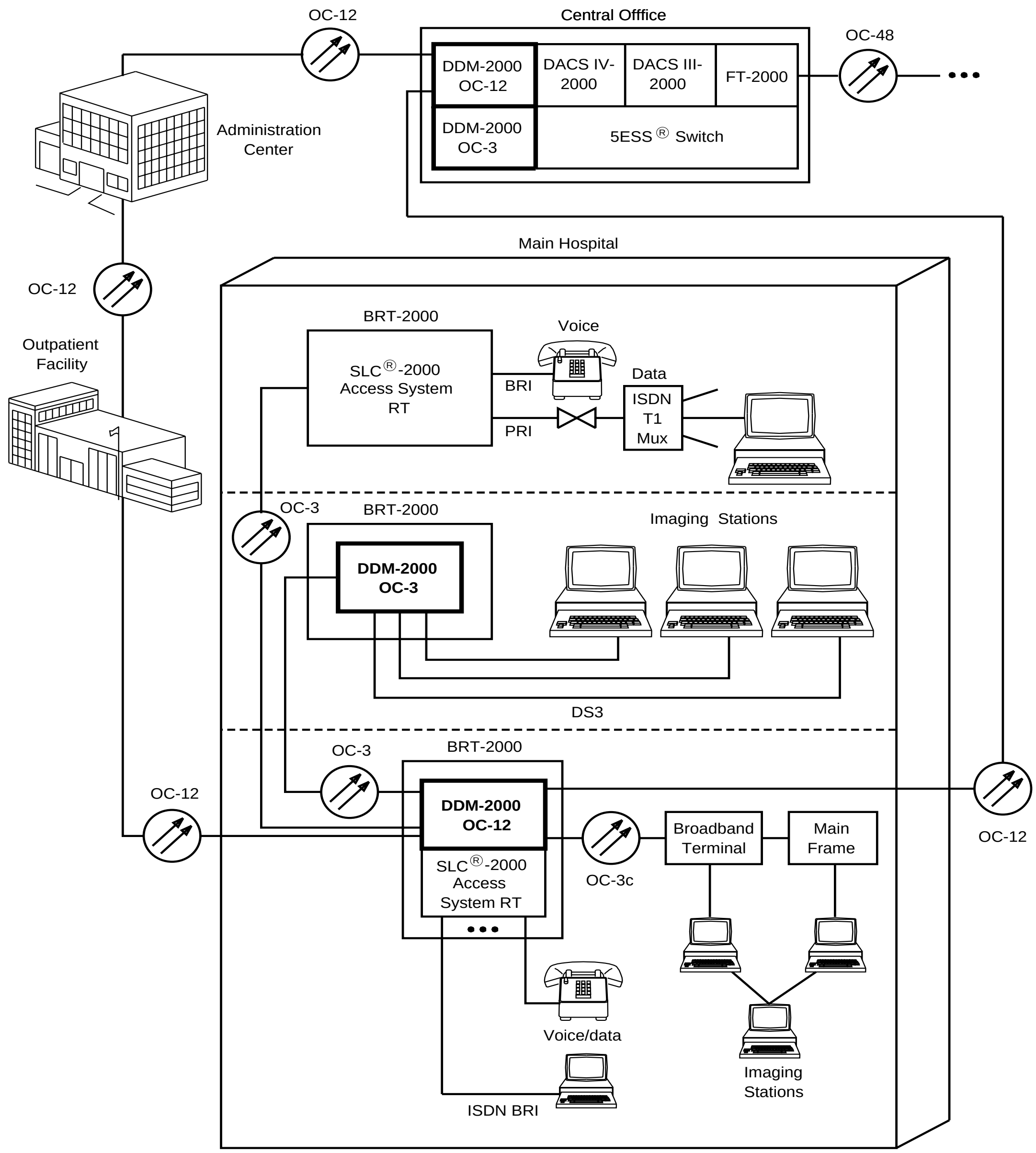

Figure 3-62. Self-Healing Medical Campus Network Application

LAN/WAN Data Networking

Increasing demands for data and multimedia applications have led to a significant growth in local area network (LAN) service needs among business customers. To transport these LAN data services over the public network, LAN routers and concentrators collect the data at a LAN location and the LAN circuit pack maps it into traditional DS1 telephone network transmission signals. These DS1 telephony signals can then be transmitted over an Access/Transport Network another location where the data can be mapped onto the LAN circuit pack (see Figure 3-63). DDM-2000 OC-3 Multiplexers are ideally suited to serving the growing demands for such LAN services. The DS1s from the LAN circuit pack can be multiplexed into a DS3 by a transmultiplexer circuit pack and connected to an ATM edge switch for transmission over the ATM transport network (see Figure 3-64) or a facilities ring SONET network. Using such an external LAN/ATM switch approach, DDM-2000 OC-3 Multiplexers can provide the necessary transport and bandwidth management capabilities to meet the business customer LAN interconnect service needs. Delivering LAN interconnect services using DDM-2000 provides the same high level of reliability and availability for these services as is supported for all other premium business services. Beginning with Release 15.0 , the Low Speed slots of the DDM-2000 OC-3 shelf will support the LAN circuit pack to be used to interconnect a LAN through the IEEE standard 802.3 compliant interface.

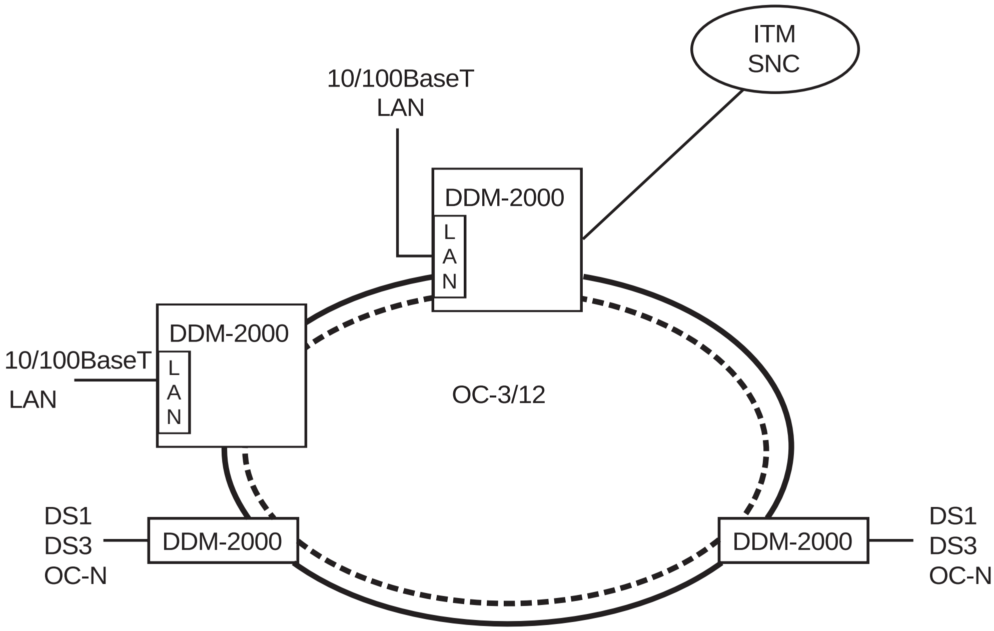

Figure 3-63. LAN/WAN Data Networking Using DS1 Cross-Connections

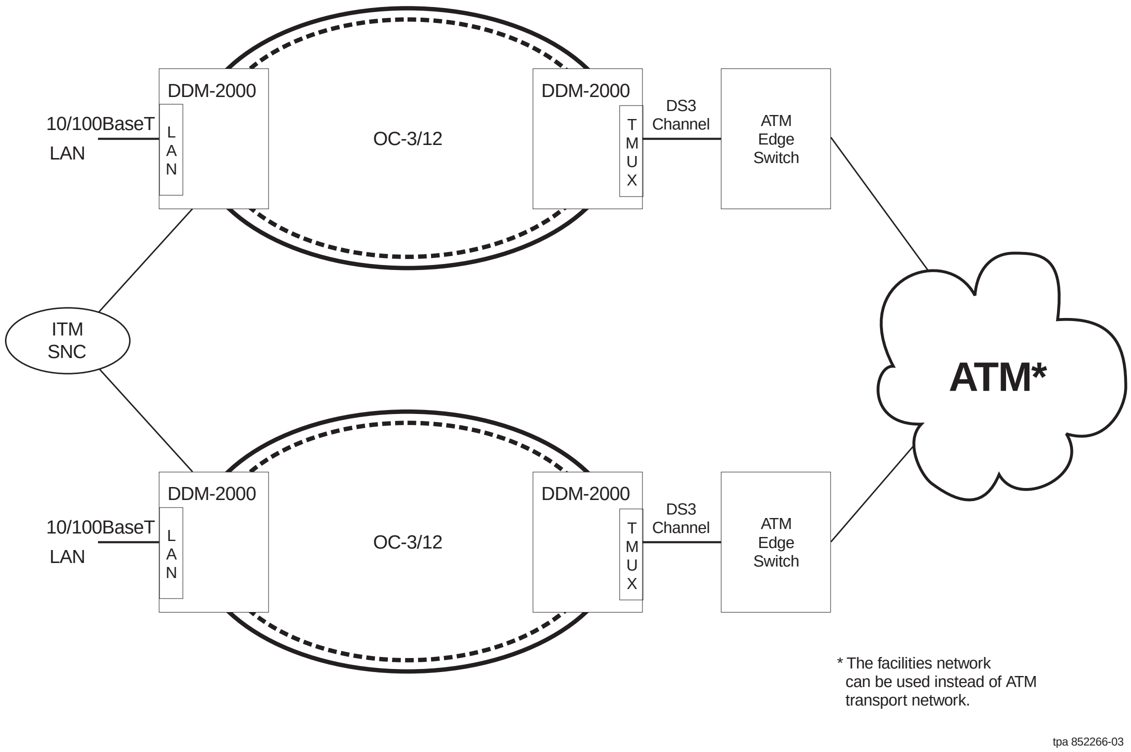

Figure 3-64. LAN/ATM Data Networking Using Transmultiplexer Circuit Pack

Release 11.0 introduces a DS3 Data Services Interface circuit pack (BBG19) for use with data edge devices. Figure 3-65 shows an example of the DDM-2000 providing ring access to ATM Switch. Up to four BBG19s can be installed in the DDM-2000 function units connecting data edge devices with services such as Ethernet, Token Ring, ATM, FDDI, Frame Relay, and others to the SONET access ring.

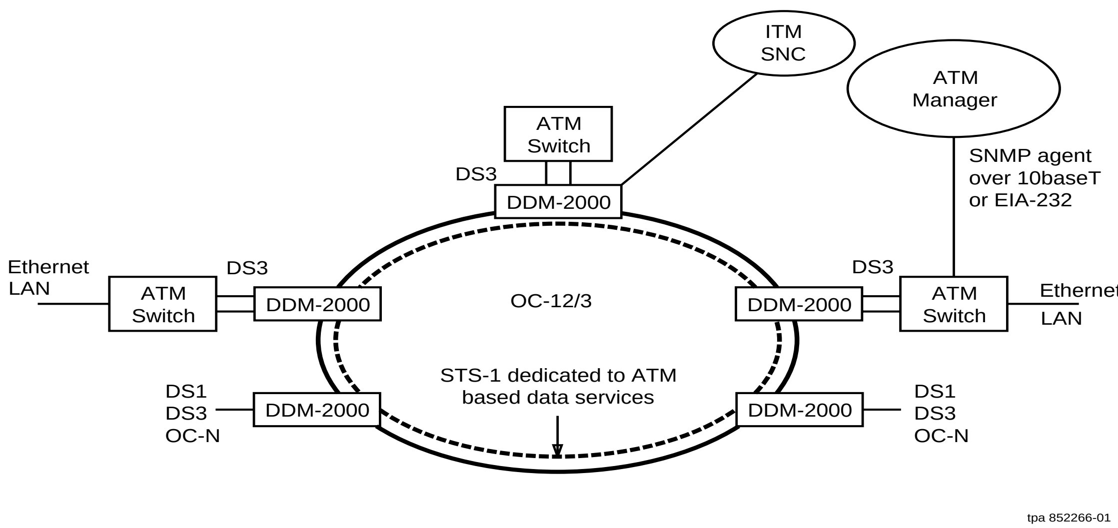

Figure 3-65. DDM-2000 Data Service with ATM Switch

Gateway Between SONET and Asynchronous Interfaces

Figure 3-66 shows an OC-12 STS-1 drop and continue to DS3 interface application for DDM-2000 OC-12 ring releases. The application is a DRI network with the following components and releases:

- DDM-2000 OC-3 Multiplexers with Release 7.1 or later software/*SLC*-2000 with Release 3.1 or later software path switched ring with VT1.5 drop and continue to EC-1 interfaces.
- DACS IV-2000 Release 3.0 or later to provide EC-1/DS3 (M13) conversions and cross-connections
- DDM-2000 OC-12 Multiplexers with Release 3.1 or later software.

This configuration is a specific application for interfacing DS1 signals at one end of a SONET system and DS3 interfaces at the other end.

NOTE:
A complete loss of CO 1 or CO 2 would protect the end-to-end path. However, unless there is a specific application requiring this gateway functionality, it is recommended that DRI be done with standard SONET EC-1 interfaces. This is because incoming asynchronous DS3 failures, such as AIS at drop and continue nodes, will not generate SONET STS AIS if drop and continue cross-connections are made on a 3DS3 circuit pack. As a result, path protection switching will not occur on the OC-12 ring resulting in unusable signals at the terminating end. (R5.1 OC-12.) DS3 LOS, however, will generate AIS.

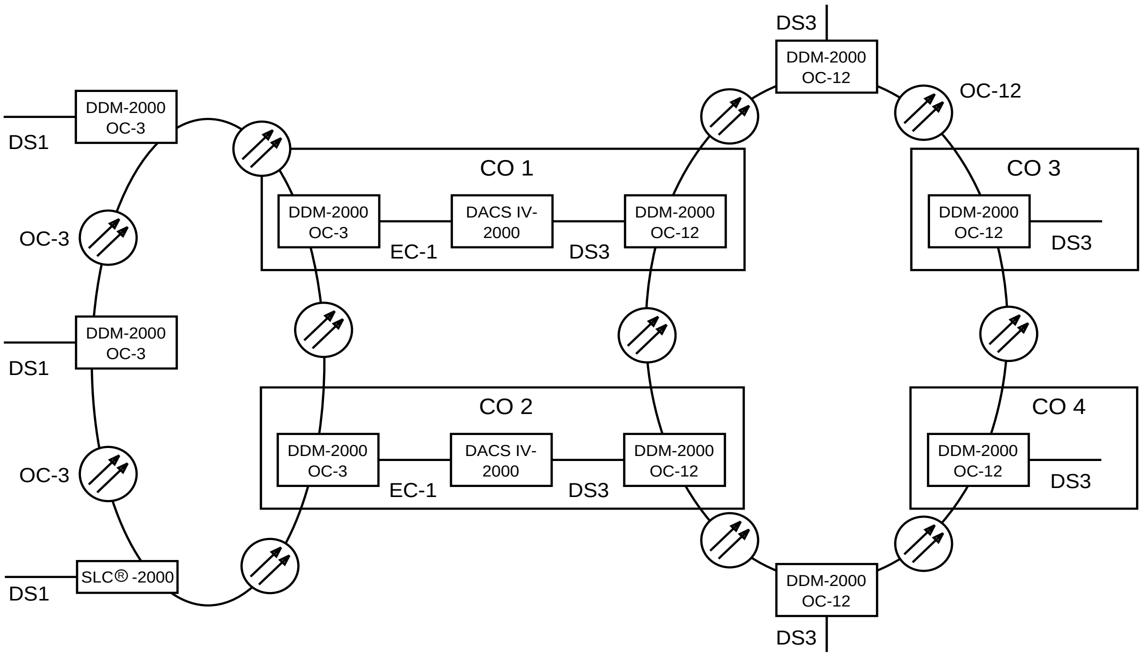

Figure 3-66. OC-12 STS-1 Drop-and-Continue to DS3 Interfaces

STS-3c Video Broadcast Application

Video applications are becoming increasingly more important in the competitive home entertainment industry. The DDM-2000 OC-12 Multiplexer can be the backbone for video distribution needs as it supports two STS-3c video cross-connection types:

- COV - Video cross-connections at central offices
- RTV - Video cross-connections at remote terminals

Figure 3-67 shows the video broadcast application for the DDM-2000 OC-12 Multiplexer. In this application, incoming STS-3c signals at a "head-end" (cross-connection type **COV**) OC-12 shelf are simultaneously dropped at any number of remote OC-12 terminals (cross-connection type **RTV**). This provides the capability of simultaneously transmitting up to eight STS-3c video feeds (using both slots of fn-A/B/C and D, when equipped with OC-3 or IS-3 interfaces) to remote sites.

Significant features of this application are:

- Both inner and outer rings (mb1 and mb2) distribute up to four STS-3c unprotected one-way signals. These signals are then connected to OC-3 or IS-3 circuit packs.
- The STS-3c signals can be provisioned in pairs (two, four, six, or eight) and unused time slots can be used for other ring applications.

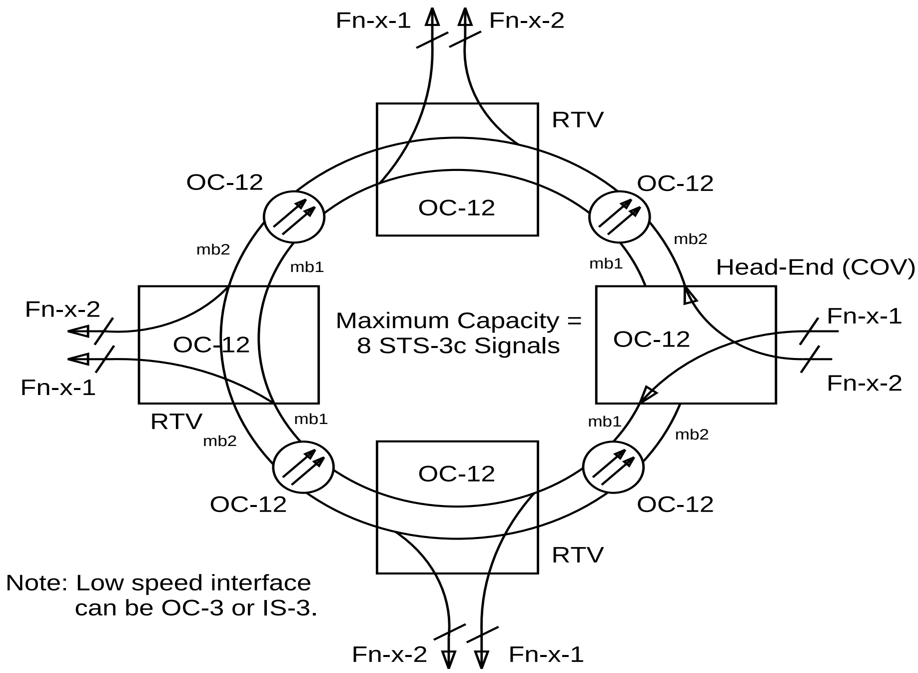

Figure 3-67. STS-3c Video Broadcast Application

STS-3c Video Application ATM Interface

Figure 3-68 shows the video application for the DDM-2000 OC-12 ring used to transport STS-3c signals from one ATM switch to another. In this scenario, each OC-12 shelf is cross-connected and provisioned as **COV** type. This provides the capability of transmitting a point-to-point STS-3c video signal from one shelf to another. Significant features of this application* are:

- Both inner and outer rings (mb1 and mb2) distribute up to four STS-3c unprotected one-way signals. These signals are then connected to OC-3 or IS-3 circuit packs.
- The STS-3c signals can be provisioned in pairs (two, four, six, or eight) and unused time slots can be used for other ring applications.

* Customer experience with this application has revealed compatibility issues with some brands of ATM equipment (e.g., Cisco, Bay Network). For ATM support it is strongly recommended to use the STS-3c 0x1 application features provided in OC-12 Release 5.2 and later ring releases, unless an unprotected scheme is acceptable.

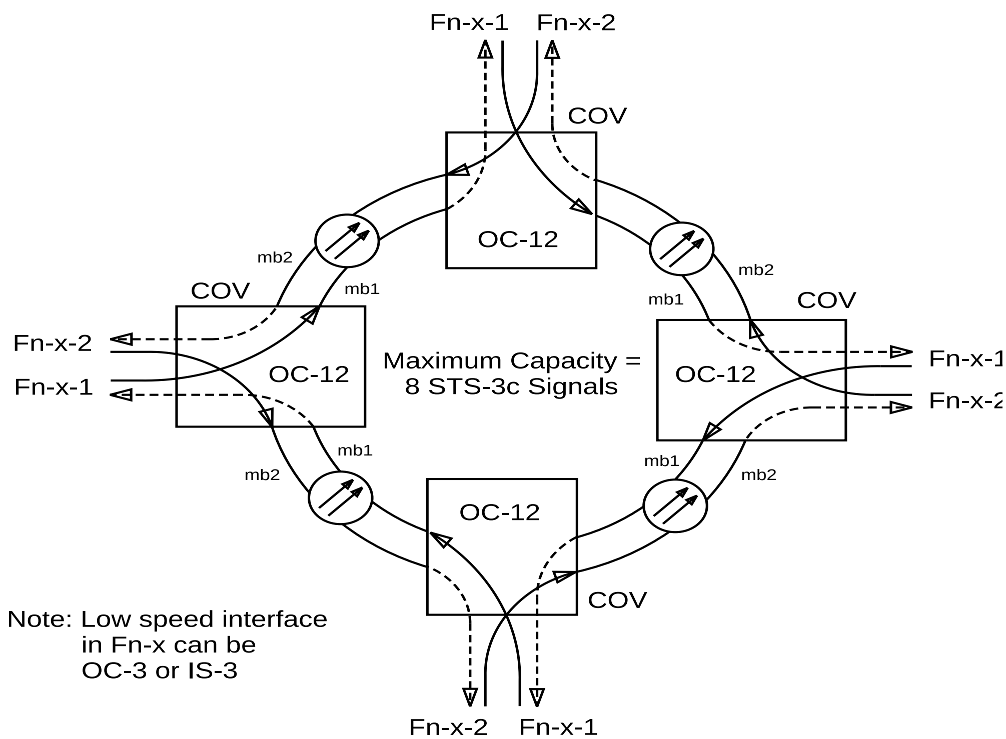

Figure 3-68. STS-3c Video Broadcast Application for ATM Interface

Locked STS-3c (0x1) Broadband Services

Beginning with Release 5.2 DDM-2000 OC-12 Multiplexer and with Release 15.0 DDM-2000 OC-3 Multiplexer when the MAIN slots are equipped with 29-type OLIU OC-12 optics, the OC-12 ring will transport STS-3c 0x1 services through OC-3/IS-3 interfaces in its function units. The DDM-2000 OC-3 Multiplexer OLIUs are 22-Type. The DDM-2000 OC-12 Multiplexer uses 21-Type OLIUs in its function units.

STS-3c path switching does not take place on the DDM-2000 OC-12 ring; it is executed elsewhere in the network (e.g., when the OC-12 ring transports ATM STS-3c traffic path switching is performed through the external ATM-based router).

Figure 3-69 and Figure 3-70 shows an STS-3c 0x1 application. Each OC-12 node provisions the same dropped STS-3c time slot as other nodes on the same ring. For different applications, an OC-12 node can assign the other STS-3cs to

different time slots at different sites. With 0x1 applications the OC-12 ring passes the contents of these STS-3c time slots between the low-speed OC-3/IS-3 lines and the OC-12 high-speed lines without terminating them or performing path protection switching.

Since the STS-3c traffic is received by the low-speed interfaces and transmitted as two copies on the OC-12 ring (one clockwise, one counterclockwise), the ring capacity is limited to the OC-12 line rate.

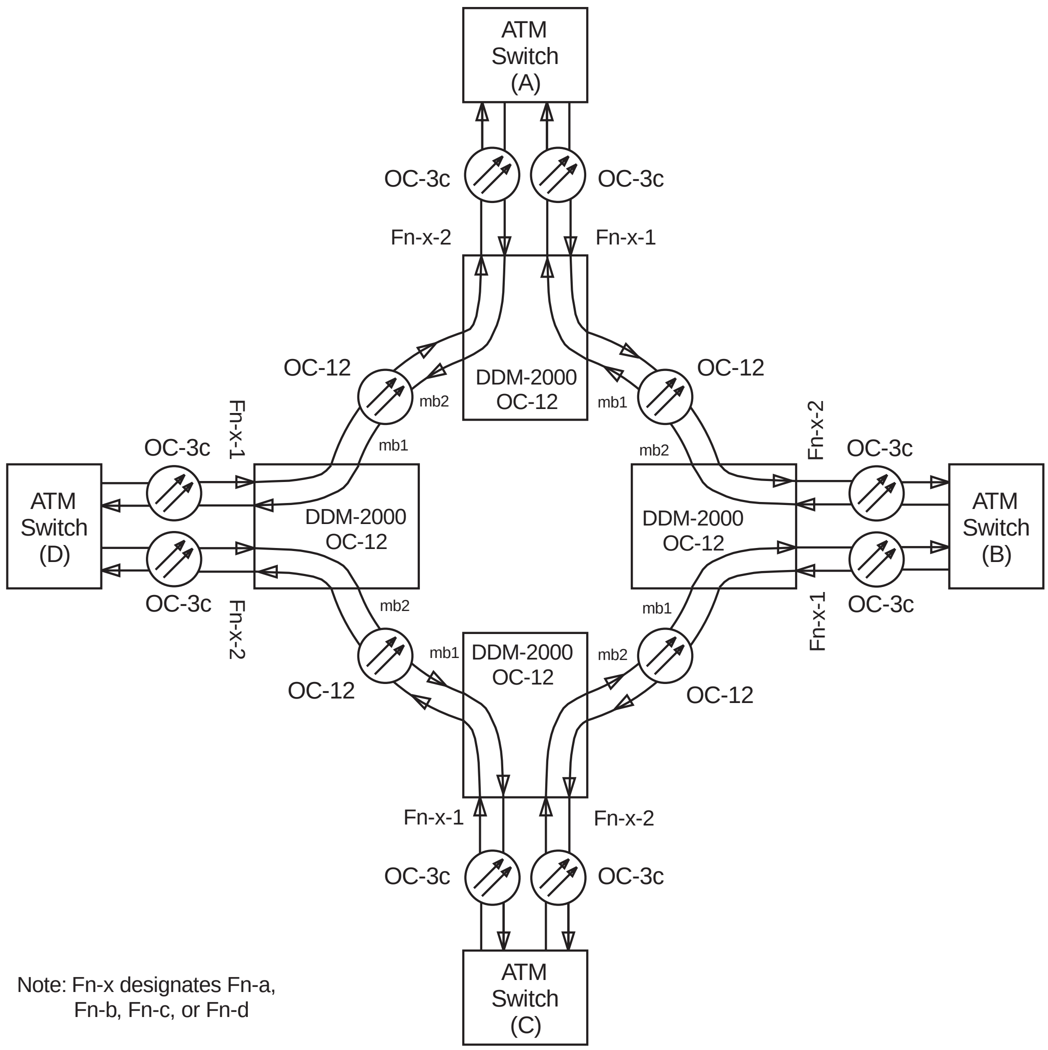

Figure 3-69. Locked (0x1) STS-3c - Broadband Services Using DDM-2000 OC-12 Multiplexer

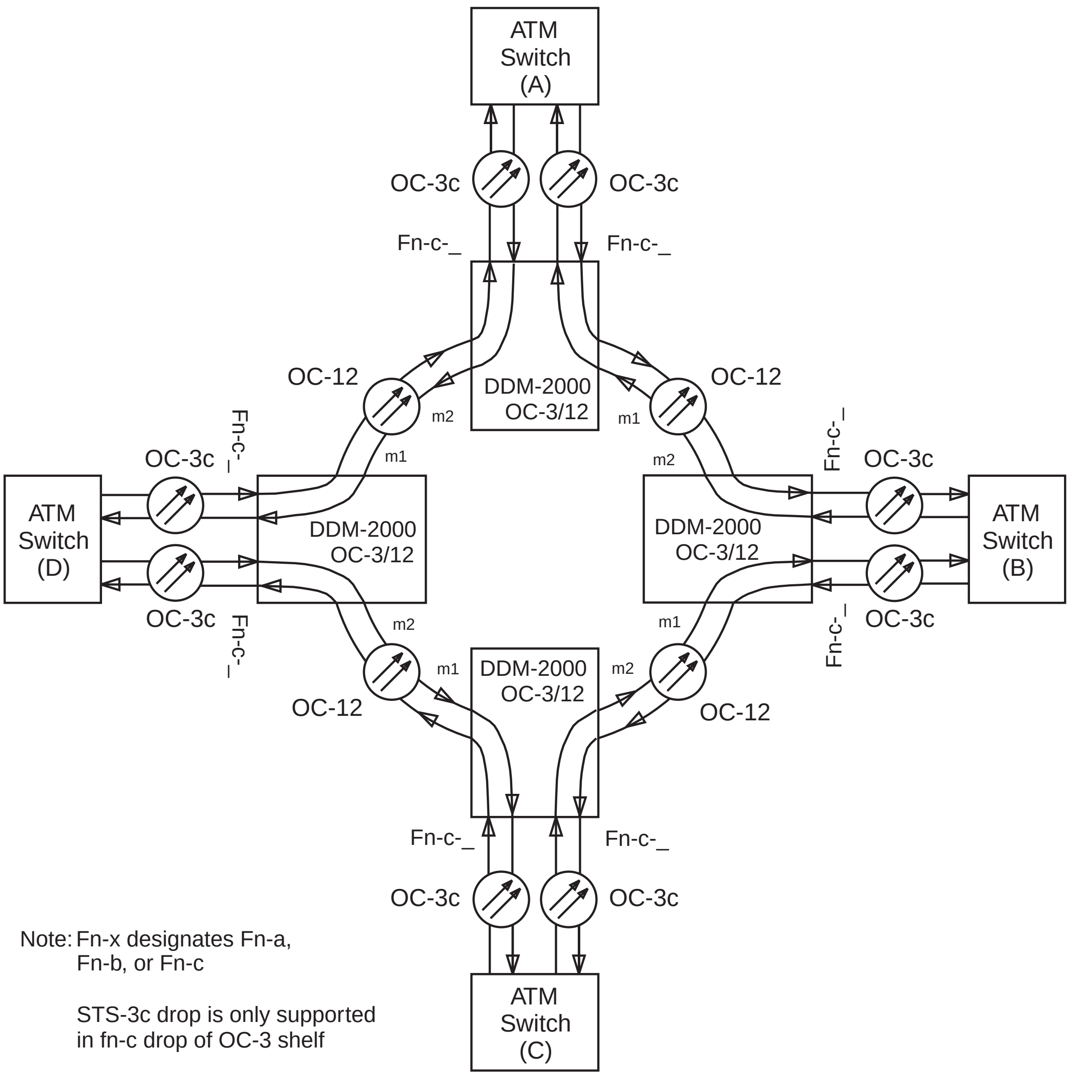

Figure 3-70. Locked (0x1) STS-3c - Broadband Services Using DDM-2000 OC-3 Multiplexer With OC-12 Optics

Teleprotection and SCADA Applications

Electric utilities are facing an unprecedented demand for increased communications bandwidth to support modern operations and business applications such as substation automation, computer networking, and video teleconferencing. Many electric utilities are installing SONET fiber optic backbones to meet these needs. SONET fiber optic backbones are a valuable communications resource that can also be used for real time protective relay and supervisory control and data acquisition (SCADA) applications.

DDM-2000 OC-3, DDM-2000 OC-12, and DDM-2000 FiberReach Multiplexers can be used in a flexible backbone network among electrical substations and other important sites. These systems provide an innovative "locked cross-connection" feature that enhances the ability of SONET rings to transport protective relay and SCADA communications. The locked cross-connection feature meets the teleprotection requirements for minimum and stable transmission delay, minimum system outage during a protection switch, and DS0 level bandwidth management at all ring nodes.

The locked cross-connection feature allows a DS1 to be removed from the TR-496 compliant VT path protection switching algorithm and provisioned as an unprotected path between any two nodes on the ring. As shown in Figure 3-71, locked cross-connection can be used to interconnect adjacent nodes all the way around SONET rings, thereby permitting access to the DS1 at each SONET node. Figure 3-71 shows a single DS1 locked between ring nodes, but this can be extended to an arbitrary number of DS1s within the available SONET bandwidth. This locked cross-connection feature fixes the ring rotation (and delay) of the DS1 paths on the ring and also permits DS0 grooming of the DS1s at each DDM-2000 or DDM-2000 FiberReach node using an external drop/insert multiplexer, such as the RFL 9001 Intelligent Multiplexer. Figure 3-71 shows the DDM-2000 interconnecting at the DS1 level with an adjacent RFL 9001 Intelligent Multiplexer that, in turn, connects on the low-speed side to protective relay and SCADA equipment. Specially designed channel units in the RFL 9001 Intelligent Multiplexer detect when a fault occurs on the power line or substation and communicate at the DS0 level with other substation nodes to isolate the power grid fault. See Section 5, "Operations, Administration, Maintenance, and Provisioning," for more information on the locked cross-connection feature.

In addition to the efficient DS0 grooming capability, the RFL 9001 Intelligent Multiplexer implements its own protection algorithm that can restore the DS0 level circuits within the locked cross-connections should the ring be cut. This algorithm operates much faster than the SONET TR-496 algorithm, thereby minimizing system outage during a protection switch.

Figure 3-71 also shows an optical drop/insert DS1 extension from the SONET rings implemented with RFL 9001 Intelligent Multiplexers. This extension is useful for serving low bandwidth sites remote from the SONET backbone. The figure shows a single host DDM-2000 interconnecting the rings, but the application could be a DRI to provide node survivability.

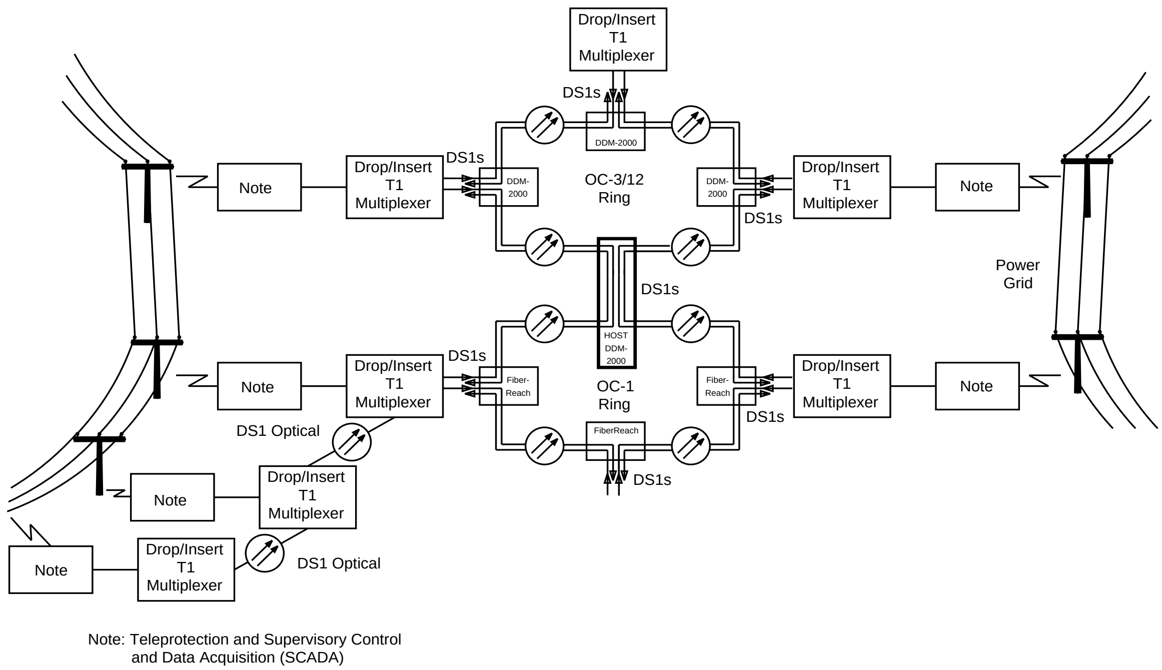

Figure 3-71. Teleprotection and SCADA Application

Intelligent Vehicle Highway System (IVHS) Applications

IVHSs are beginning and will grow to play a major role in the roadway systems of the future. Their primary use in the near-term is to reduce congestion. This is done in several ways.

- The IVHS provides more efficient and optimal traffic management which attempts to avoid congestion in the first place.
- The IHVS provides better management of congestion caused by random occurrences such as accidents or breakdowns.
- The IVHS eliminates many of the foreseeable causes of congestion, such as toll-taking, by automating these functions.

In the future, these systems will also help travelers plan their routes by providing up-to-the-minute traffic and highway information. The DDM-2000 OC-3 and OC-12 Multiplexers are a perfect match for the networking needs of these systems.

Figure 3-72 shows a typical IVHS application. An IVHS network calls for carrying data between roadside equipment, such as traffic counters, speed sensors, variable messaging signs, video cameras, toll-taking equipment, pay phones and call boxes, and a traffic operations center, where incoming data is processed and responses are generated. The DDM-2000 OC-3 and OC-12 Multiplexers provide a perfect backbone for carrying this information. The DDM-2000 OC-3 Multiplexer SONET ring capability, when coupled with diverse fiber routing on opposite sides of the roadway, makes the backbone completely self-healing in the face of failures. Such reliability is absolutely essential, especially as travelers come to depend more and more on IVHS networks. The VT1.5 and STS-1 bandwidth management capabilities of the DDM-2000 OC-3 and OC-12 Multiplexers allow flexible allocation of bandwidth to match the dynamics of a roadway system which is undergoing unpredictable changes in traffic patterns, breakdowns, accidents, and repairs. Such bandwidth management provides a system which meets the IVHS network needs in a cost-effective manner. DDM-2000 OC-3 and OC-12 Multiplexers completely meet the transmission needs of an IVHS network.

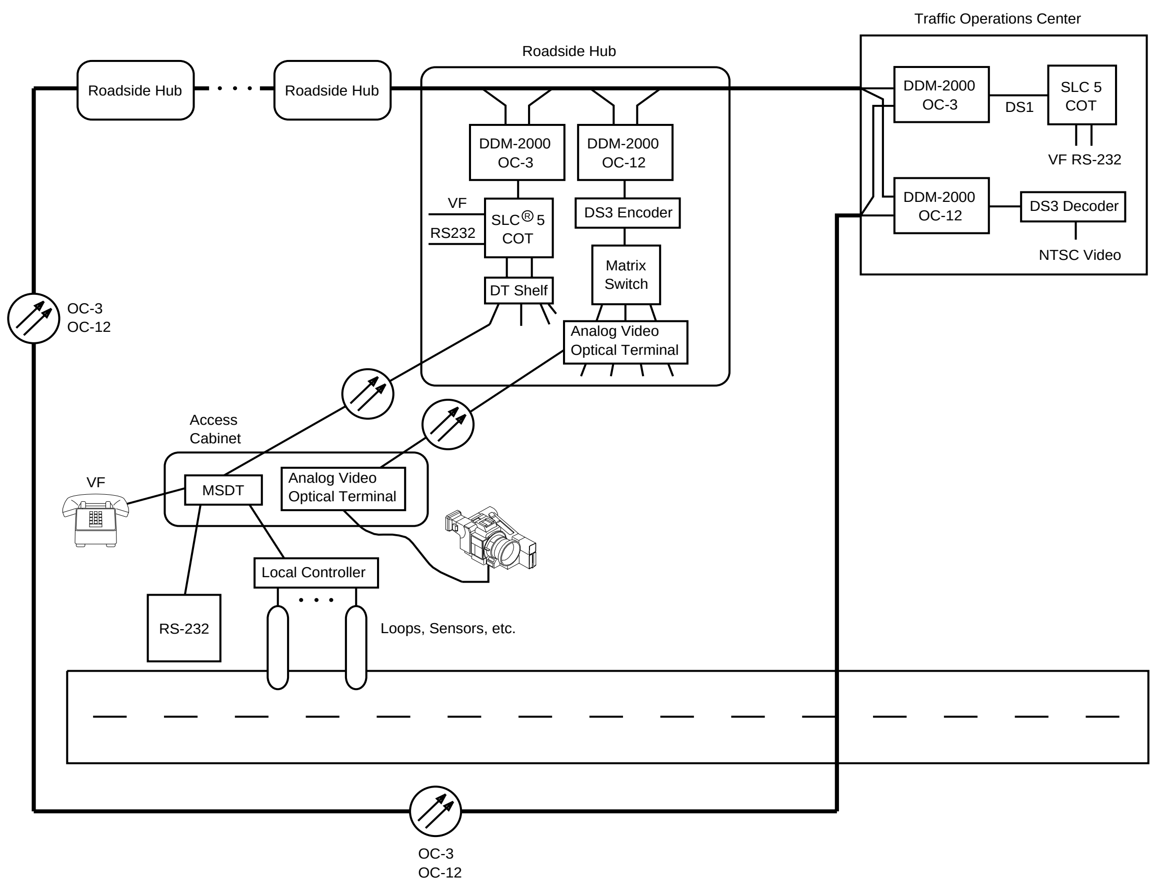

Figure 3-72. Intelligent Vehicle Highway System (IVHS) Application

DS1 Performance Monitoring for Tariff Verification

It is critical in the growing, high-reliability DS1 services market that DS1 performance be accurately measured and recorded in order to verify the terms of a DS1 tariff. The DDM-2000 OC-3 Multiplexer's DS1 PM capability allows a service provider to access this lucrative market by gathering and maintaining DS1 path performance data. The service provider can then use this data to confidently verify the terms of a DS1 tariff.

Figure 3-73 demonstrates a typical configuration for DDM-2000 OC-3 Multiplexers configured to provide DS1 PM. In this example, a business customer is using DS1s to interconnect a LAN at their remote office with an LAN at their corporate headquarters. The DS1 circuit is provided by a public carrier. Starting at the corporate headquarters (location A), an extended superframe (ESF) formatted DS1 is fed into the DDM-Plus or DDM-2000 FiberReach and DDM-2000 OC-3 equipment, carried across the public network, and delivered to the LAN bridge/ router at the company's remote office (location Z). There the LAN bridge/router (owned by the business customer) evaluates the number of bit errors occurring in the trip from headquarters to the remote office and sends a message in the opposite direction of the ESF data link, reporting these error statistics. The DDM-2000 OC-3 Multiplexer receives this message and stores the information locally on its DS1PM circuit pack. The DDM-2000 OC-3 Multiplexer does this continuously, gradually building a repository of DS1 performance data on the link from location A to location Z. This information is always available to the public carrier's operations center by querying the DDM-2000 OC-3 Multiplexer via its CIT or TL-1 links. Similarly, the DDM-2000 OC-3 Multiplexer at the company headquarters maintains all the performance data on the link from location Z to A and this data is also transmitted over the TL1 interface. Taken together, these two sources of data provide verification of the 2-way DS1 link between location A and Z.

Beginning with Releases 13.0 and 11.1, a DS3 Transmultiplexer (TMUX) circuit pack is available for installation in the function unit slots of the DDM-2000 OC-3 shelf. The TMUX accepts an M13 or C-bit formatted DS3 signal and demultiplexes it into 28 DS1s. Performance monitoring can then be done at the DS3 and DS1 (measuring the same path parameters as the DS1 PM circuit pack) levels . This new circuit pack eliminates the need for a separate M13 multiplexer and can add versatility to your tariff verification capabilities (TMUX not shown in Figure 3-73). See Figure 3-74 for a DS3 Transmultiplexer application.

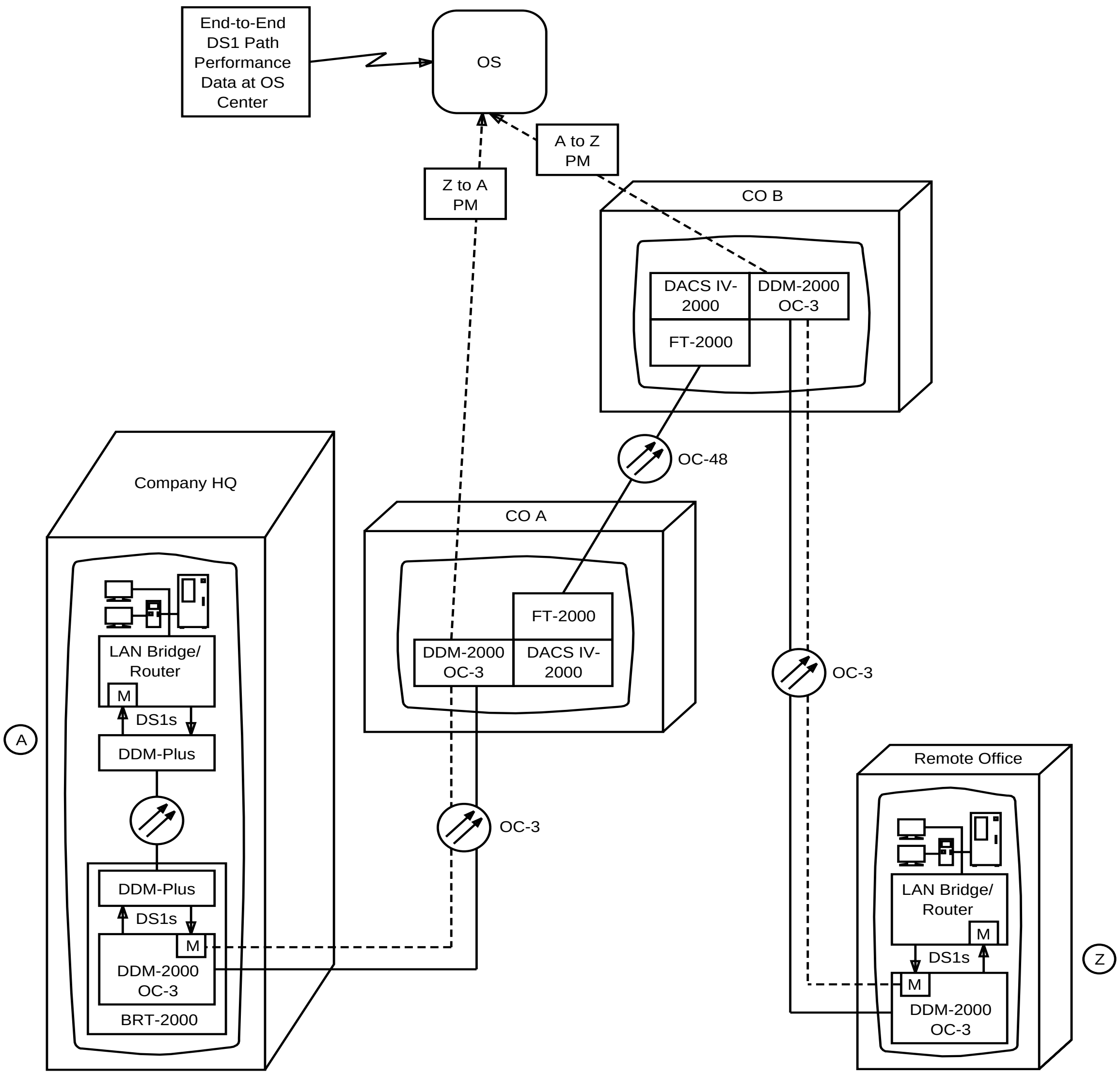

Figure 3-73. DS1 Path Performance Monitoring for Tariff Verification

DS3 Transmultiplexer (TMUX) Application

The transmultiplexing feature provides an economical means for collection of DS1s at a customer site, and handoff of a fully groomed asynchronous DS3 to the interexchange carrier without the need for external M13 multiplexers.

Figure 3-74 shows an example of a total of 28 DS1s connected to three NEs and transported on three different STS-1s. The DS1s are collected and groomed in the DDM-2000 OC-3 shelf on the right, multiplexed to a DS3, and then passed on to the interexchange carrier. The DS3 Transmultiplexer (TMUX) circuit pack provides this feature.

In the transmit direction the TMUX accepts one DS3 signal and demultiplexes it into 28 DS1s. Performance monitoring can then be performed on the DS1s before they are mapped into floating VT1.5s. The 28 VT1.5s are then multiplexed into STS-1s before being sent to the high-speed OLIU. In the receive direction the reverse process takes place. The TMUX circuit pack also provides enhanced DS3 performance monitoring as well as DS1, VT, and STS-1 PM.

- DS1s that form DS3 can come from multiple STS-1s

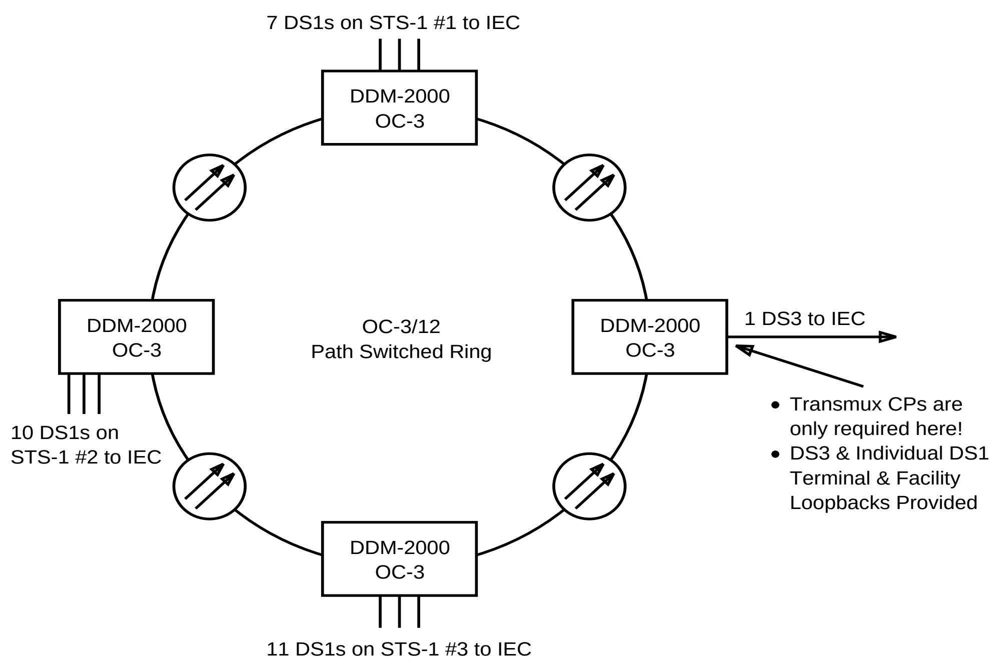

Figure 3-74. DS3 Transmultiplexer Application

High bit rate Digital Subscriber Line (HDSL) Application

The HDSL circuit pack (BBF8) provides HDSL interface capability on the DDM-2000 OC-3 shelf to compatible PairGain™ equipment at the customer premises. It allows the transport of T1 payloads, for up to 12,000 feet, over two metallic 24 AWG twisted-pair lines. Figure 3-75 shows examples of HDSL circuit packs providing this capability in both the DDM-2000 OC-3 and the DDM-2000 FiberReach shelves. Applications for business customers, the private network, cell sites, PBXs, customer premises equipment (CPE), and other applications are supported.

The BBF8 circuit pack fits into the low-speed slots and provides two, four-wire HDSL interfaces. Each interface provides a full DS1 payload capacity mapped to a SONET VT1.5 and then VT cross-connected into an STS-1. Once in SONET, the DS1 payload is treated as a normal DS1.[*]

[*] Note that the HDSL circuit pack can be installed in DDM-2000 OC-3 shelves running linear Releases 6.2 and later, and ring Releases 7.1 and later. Refer to information included with each circuit pack for provisioning instructions.

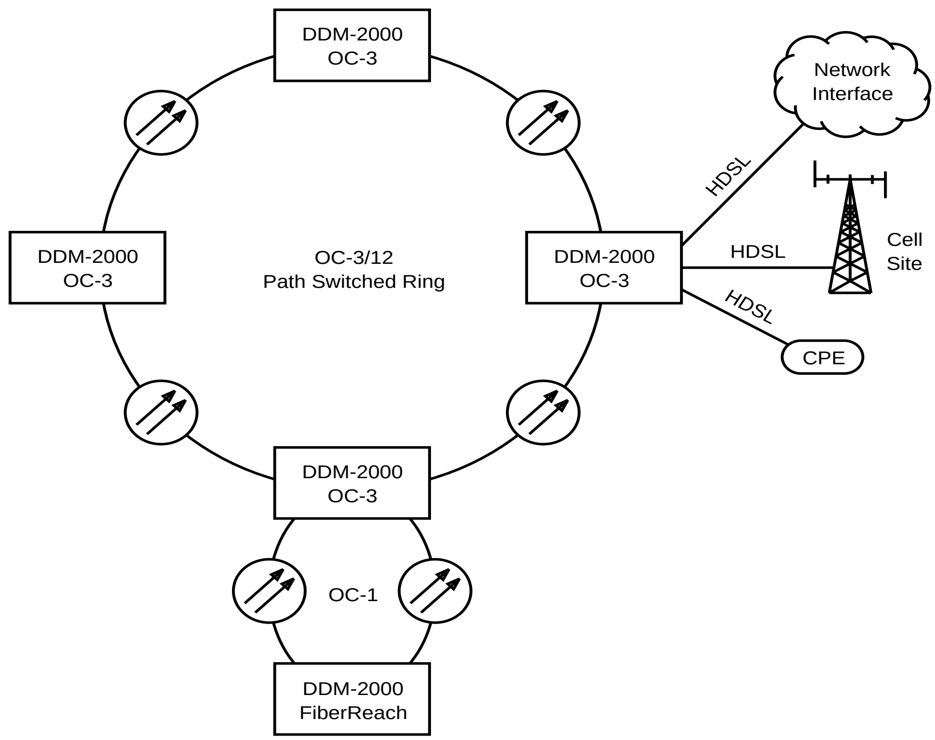

Figure 3-75. HDSL Application

Product Description

4

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Product Description

4

Overview

This section provides a more detailed view of the architecture and features of the DDM-2000 OC-3 and OC-12 Multiplexers. Following a physical description of the shelf and power architectures, the transmission, synchronization, and control features of both DDM-2000 OC-3 and DDM-2000 OC-12 Multiplexers are described to the circuit pack level. DDM-2000 OC-3 and OC-12 Multiplexers were designed together as a product family. As a result, they share a common design philosophy, circuit packs, and operations and maintenance features.

Physical Design

DDM-2000 OC-3 Multiplexer Shelf

The DDM-2000 OC-3 Multiplexer shelf is shown in Figure 4-1 and Figure 4-2. Figure 4-1 is the Group 4 Shelf. The Group 4 shelf measures 8.5 inches high by 21.25 inches wide by 13.25 inches deep and fits in a standard 23-inch wide bay. The Group 4 shelf provides wider clearance than the Group 1 or 3 shelf between the front cover and the circuit pack faceplates. The Group 4 shelf or a Group 3 shelf retrofitted with a front cover upgrade kit (see Table 7-1) is required when using the 27G/27G2-U, 24G-U/24H-U, or 29G-U/29H-U OLIUs.

The Group 1 or Group 3 shelf measures 8.5 inches high by 21.25 inches wide by 12 inches deep and fits in a standard 23-inch wide bay. User panels are interchangeable between shelves (old in the new or new in the old). Each shelf is a stand-alone entity with its own fiber cabling and interfaces to DSX-1, DSX-3, STSX-1 office power, and operations interfaces. Cabling for office alarms, parallel telemetry, craft interface terminal (CIT) interfaces, DS1 timing inputs, and telemetry byte-oriented serial (TBOS) can be shared among shelves in a bay. The default configuration provides rear access cabling. Front access through dangler cables is available as an option. Front-access optical connectors interconnect to optical fiber facilities and facilitate shelf loopback and fiber tests. The optical connectors are mounted on the optical line interface unit (OLIU) circuit pack faceplate.

The DDM-2000 OC-3 Multiplexers provide Lucent's universal optical connector on all OLIUs. These OLIUs are designated by a -U. The universal optical connectors are receptacles on the faceplate of the OLIUs that allow a single OLIU to support either *ST*®, FC-PC, or SC connectors as needed.

A DDM-2000 OC-3 multiplexer shelf consists of the following:

- 36 circuit pack slots
  - 26 four-inch slots
  - 10 eight-inch slots
- User panel
- Fully connectorized backplane
- Front and back covers.

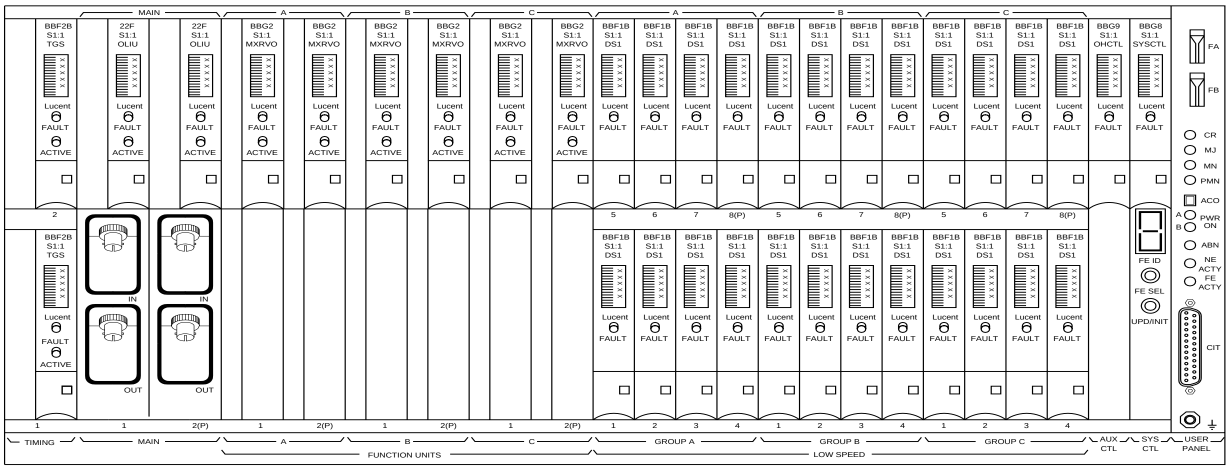


Figure 4-1. DDM-2000 OC-3 Group 4 Shelf — Front View

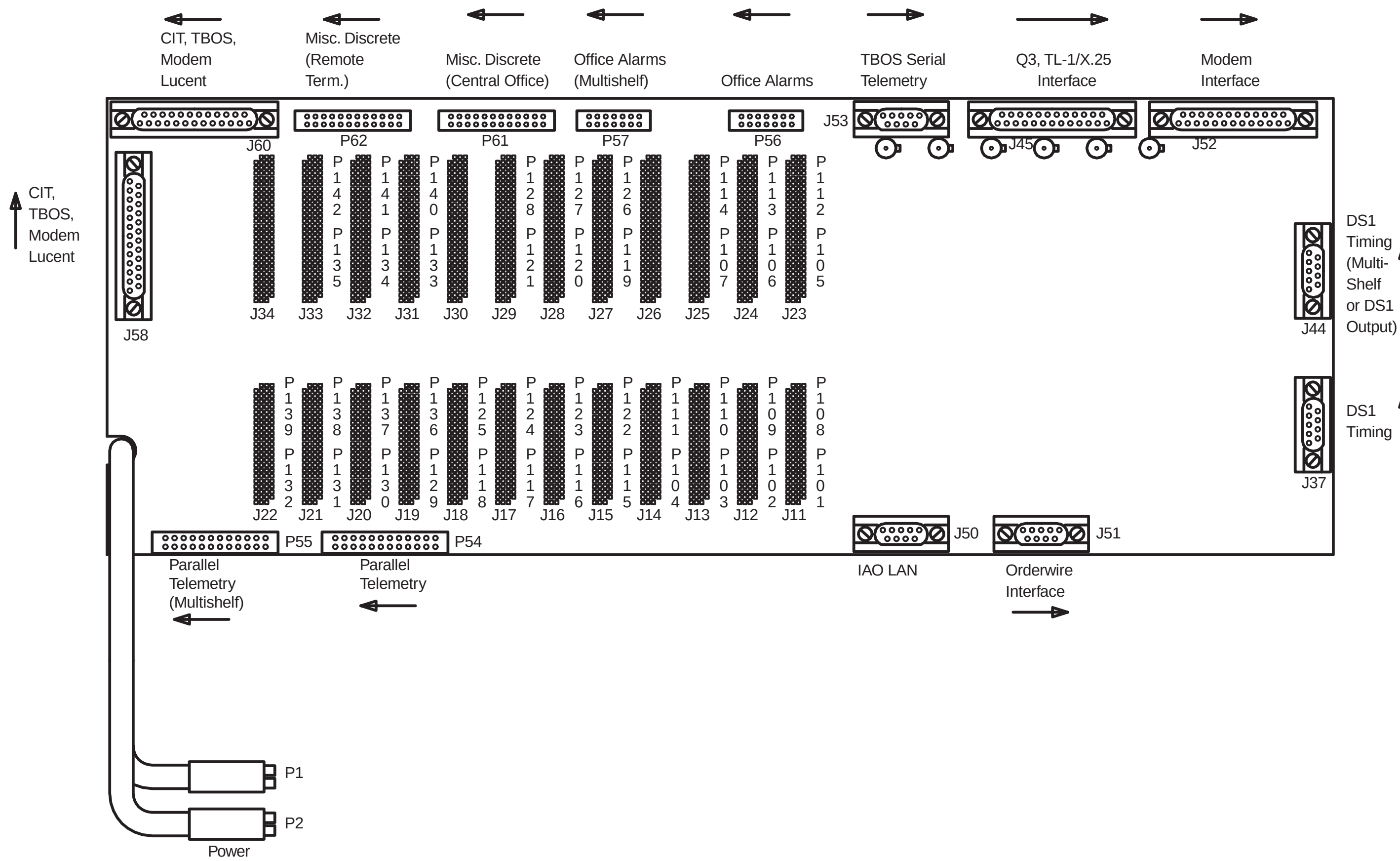


Figure 4-2. DDM-2000 OC-3 Group 4 Shelf — Rear View

Table 4-1 lists the DDM-2000 OC-3 Multiplexer plug-ins.

Table 4-1. DDM-2000 OC-3 Plug-Ins

Product Code	Functional Name	Functional Designation
BBF1B	DS1 Low-speed Interface	DS1
BBF2B	Synchronous Timing Generator	TGS
BBF2C	Synchronous Timing Generator	TGS
BBF3	DS1 Performance Monitoring	DS1PM
BBF3B	DS1 Performance Monitoring	DS1PM
BBF4	Synchronous Timing Generator 3	TG3
BBF5	Jumper circuit pack	JUMPER
BBF6	T1 Extensions	T1EXT
BBF8	High bit rate Digital Subscriber Line	HDSL
BBF9	LAN Interface	LAN
BBF10	LAN Interface	LAN
BBG2B	VT-to-STS-1 Multiplexer	E-MXRVO
BBG4B	DS3 Low-speed Interface	DS3
BBG6	EC-1 Interface	STS1E (EC-1)
BBG8B	System Controller	SYSCTL
BBG9	Overhead Controller	OHCTL
BBG10	Overhead Controller	OHCTL
BBG19	DS3 Data Services Interface	DS3
BBG20	Transmultiplexer	TMUX
21D-U	IS-3 OLIU	OLIU
21G2-U	OC-3 OLIU	OLIU
21G3-U	OC-3 OLIU	OLIU
22D-U	OC-3 OLIU with TSI	OLIU
22G3-U	OC-3 OLIU with TSI	OLIU
22G4-U	OC-3 OLIU with TSI	OLIU
22D-U	IS-3 OLIU with TSI	OLIU
24G-U	OC-12 OLIU with TSI	OLIU
24H-U	OC-12 1550 nm OLIU with TSI	OLIU
26G2-U	OC-1 OLIU	OLIU
27G-U	OC-1 (Dual OC-1) OLIU	OLIU
27G2-U	OC-1 (Dual OC-1) OLIU	OLIU
29G-U	OC-12 OLIU with TSI	OLIU
29H-U	OC-12 1550 nm OLIU with TSI	OLIU
177A	Retainer	

As shown in Figure 4-1, starting at the far left, two 4-inch slots are reserved for service and protection timing circuit packs (TGS/TG3).

The next two 8-inch slots are reserved for service and protection main OC-12, OC-3, IS-3, or OC-1 OLIU circuit packs.

The following six 8-inch slots are for the function units. These slots are divided in three groups designated A, B, and C. The function unit slots can be equipped, depending on the application, with DS3, MXRVO, TMUX, STS1E or OC-3/OC-1 OLIU circuit packs.

The next section of the shelf is reserved for the DS1 low-speed interface circuit packs. These slots are also divided into three groups designated A, B, and C which correspond to the function unit groups. Each group consists of eight 4-inch slots for service and optional protection DS1 circuit packs (1x7 protected). Unused low-speed interface slots within a partially equipped group must be equipped with retainer cards (177A retainer) if DS1 protection is used.

Beginning with Release 13.0, the HDSL circuit pack will also be installed in the low-speed slots.

Beginning with Release 15.0, the T1EXT and IMA LAN circuit packs will also be installed in the low-speed slots.

The next section of the shelf consists of two 8-inch slots reserved for control circuit packs. The auxiliary control slot is reserved for a required overhead controller (OHCTL) circuit pack. The system controller slot is reserved for the system controller (SYSCTL) circuit pack.

The user panel, mounted on the right side of the shelf, consists of the following:

- Two –48 volt fuses (5A)
- Four alarm LEDs
- ACO/TEST pushbutton control
- Five (four on Group 1 and 3 shelves) status LEDs
- Craft interface terminal (CIT) port
- Electrostatic discharge (ESD) jack.
- The Group 4 shelf has an additional Power LED for each of the A & B redundant power feeds/fuses to the shelf.

Accidental insertion of same-size circuit packs in incorrect slots is prevented through circuit pack keying. Three keying combinations are provided. The key mechanism is located on the faceplate latch, with an interference mechanism on the shelf.

As shown in Figure 4-3, the front of the shelf is covered with an electromagnetic compatibility (EMC) cover. If the shelf needs to be accessed for maintenance activities, the cover is hinged to drop down 180 degrees, or it can be easily removed by pulling out when at 45 degrees. The back of the shelf is covered by an inner cover over the DS1 interface connectors and an outer cover over the rear of the shelf. All covers are necessary to meet the EMC guidelines set by the Federal Communications Commission (FCC).

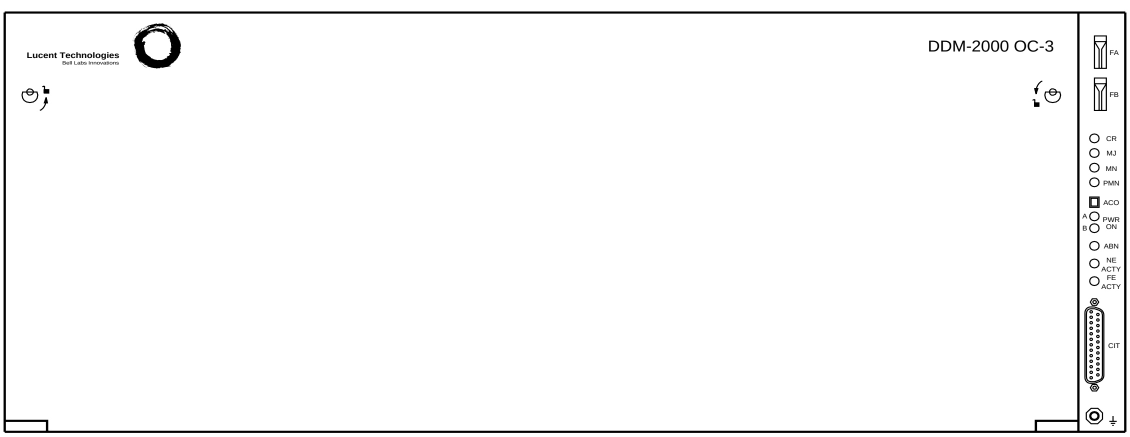


Figure 4-3. DDM-2000 OC-3 Multiplexer Front Panel

DDM-2000 OC-12 Multiplexer Shelf

The DDM-2000 OC-12 Multiplexer shelf is shown in Figure 4-4 and Figure 4-5. Figure 4-4 is the Group 4 shelf. The Group 4 shelf measures 14 inches high by 21.25 inches wide by 13.25 inches deep and fits in a standard 23-inch wide bay. It provides wider clearance between the front cover and the circuit pack faceplate. The Group 1 shelf measures 14 inches high by 21.25 inches wide by 12 inches deep and fits in a standard 23-inch wide bay. User panels are not interchangeable between shelves (old in the new or new in the old). Each shelf is a stand-alone entity with its own fiber cabling and interfaces to DSX-3, STSX-1, office power, and operations interfaces. Cabling for office alarms, parallel telemetry monitoring, CIT interfaces, DS1 timing inputs and outputs, and TBOS can be shared among other shelves in the bay. The default configuration provides rear access cabling. Front access through dangler cables is available as an option. Front-access optical connectors interconnect to fiber optic facilities and facilitate shelf loopback and fiber tests. The optical connectors are mounted on the OLIU circuit pack faceplate.

The DDM-2000 OC-12 Multiplexers provide Lucent's universal optical connector on all OLIUs. These OLIUs are designated by a -U. The universal optical connectors are receptacles on the faceplate of the OLIUs that allow a single OLIU to support either *ST*®, FC-PC, or SC connectors as needed.

A DDM-2000 OC-12 Multiplexer shelf consists of the following:

- 18 circuit pack slots
  - 2 four-inch slots
  - 9 eight-inch slots
  - 7 twelve-inch slots
- User panel
- Fully connectorized backplane
- Front and back covers.

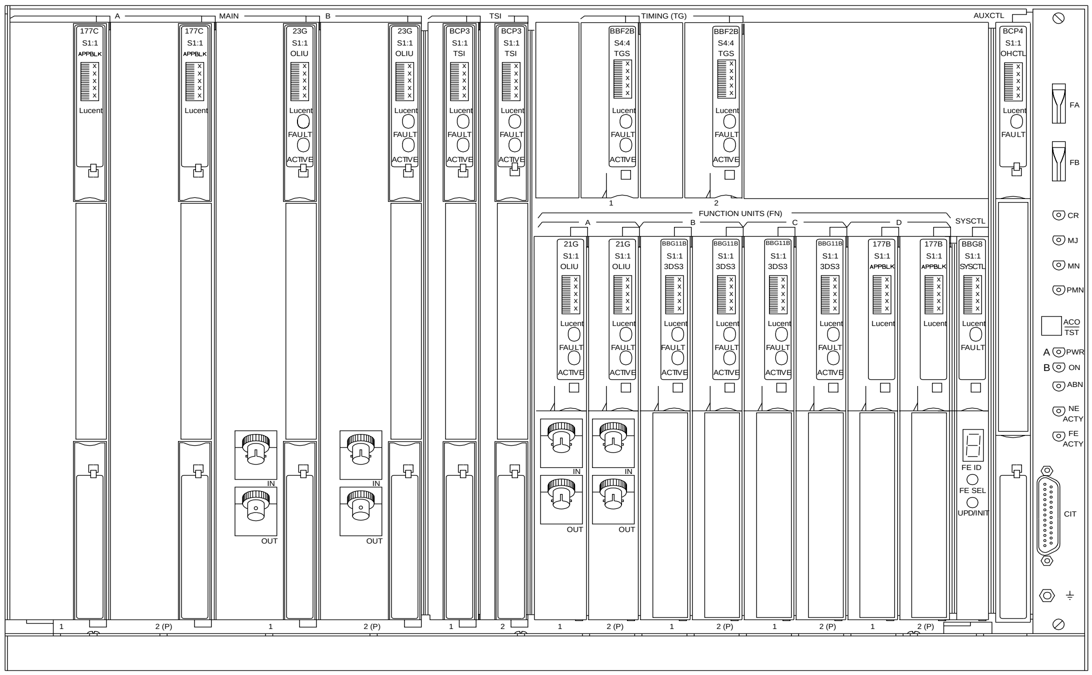


Figure 4-4. DDM-2000 OC-12 Group 4 Shelf — Front View

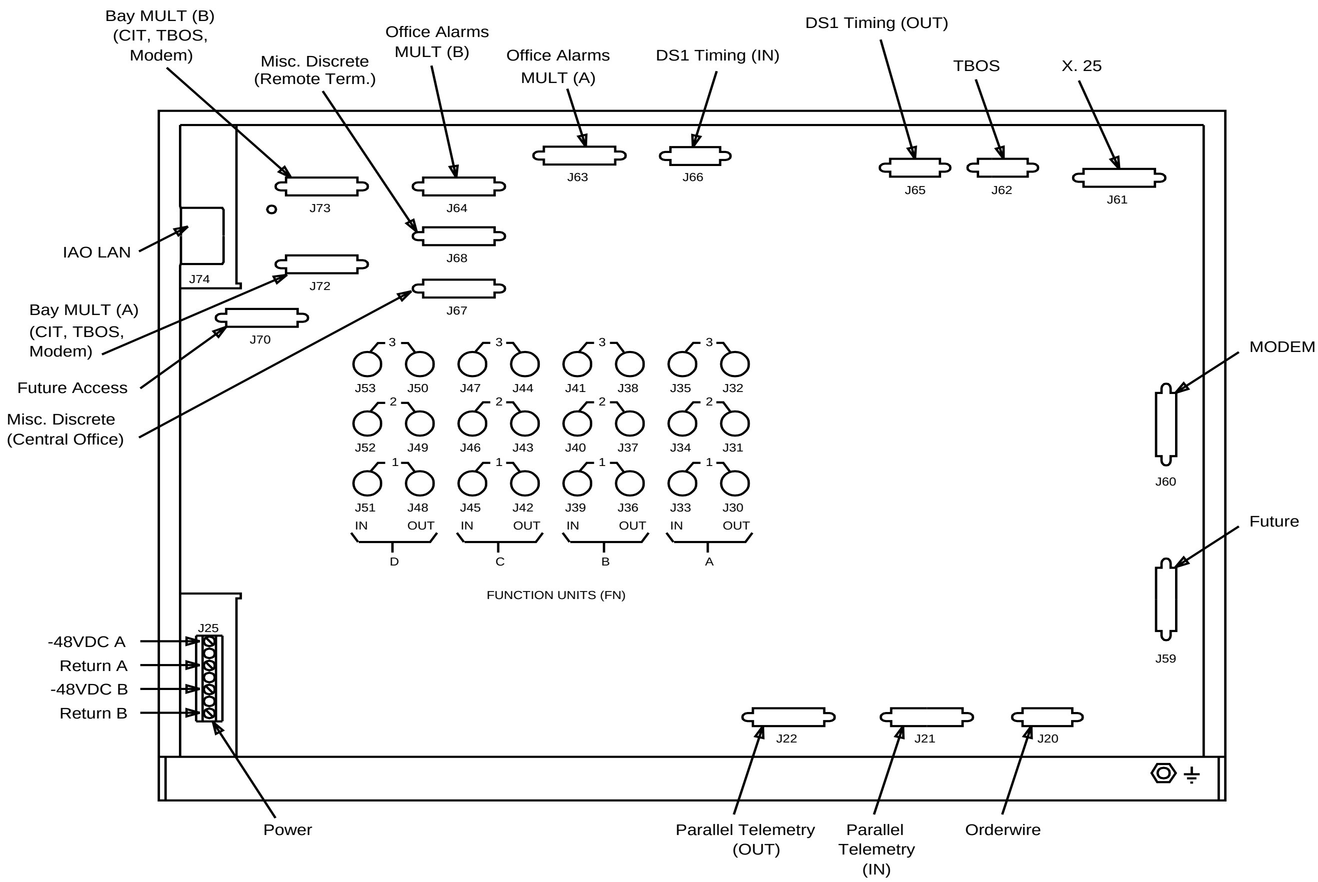


Figure 4-5. DDM-2000 OC-12 Shelf—Rear View

Table 4-2 lists the DDM-2000 OC-12 Multiplexer and OC-12 Regenerator plug-ins.

Table 4-2. DDM-2000 OC-12 Plug-Ins

Product Code	Functional Name	Functional Designation
BBF2B	Synchronous Timing Generator	TGS
BBF2C	Synchronous Timing Generator	TGS
BBF4	Synchronous Timing Generator 3	TG3
BBG11B	Triple DS3	3DS3
BBG12	Triple EC-1 Interface	3STS1E
BBG8B	System Controller	SYSCTL
BCP3	Time Slot Interchange Flex	TSI
BCP4	Overhead Controller	OHCTL
21D-U	OC-3 OLIU	OLIU
21G2-U	OC-3 OLIU	OLIU
21G3-U	OC-3 OLIU	OLIU
23G-U	OC-12 OLIU	OLIU
23H-U	OC-12 1550 nm OLIU	OLIU
177B	Apparatus Blank (8")	APPBLK
177C	Apparatus Blank (12")	APPBLK

As shown in Figure 4-4, the front view of the shelf is divided into seven functional groupings:

- Starting from left to right:
  - MAIN
  - TSI
  - TIMING (TG)
  - AUXCTL
  - USER PANEL
- Continuing below the TIMING (TG) area:
  - FUNCTION UNITS (FN)
  - SYSCTL.

Four 12-inch slots, designated MAIN, are for the Main OC-12 OLIU circuit packs. These circuit packs are arranged in two service and protection pairs designated Main A and Main B. Main A slots 1 and 2(P) must be equipped with 177C apparatus blanks (APPBLK) except when the shelf is used as an OC-12 Regenerator shelf.

Two 12-inch slots, designated TSI, are for two time slot interchange (TSI) circuit packs, service and protection.

Two 4-inch slots, designated TIMING (TG), are for two timing generator packs (TGS/TG3), service and protection.

One 12-inch slot, designated AUXCTL, is for the overhead controller (OHCTL) circuit pack.

Eight 8-inch slots, designated FUNCTION UNITS (FN), are for Function Unit circuit packs. These slots are divided into four groups designated A, B, C, and D. The Function Unit slots can be equipped interchangeably by group, with service and protection.

One 8-inch slot, designated SYSCTL, is for the main control circuit pack (SYSCTL).

The user panel mounted on the far right side of the shelf consists of the following:

- Two –48 volt fuses (10A)
- Four alarm LEDs
- ACO/TEST pushbutton control
- Five (four on Group 1 shelves) status LEDs
- CIT port
- ESD jack.
- The Group 4 shelf has an additional Power LED for each of the A & B redundant power feeds/fuses to the shelf.

Accidental insertion of same-size circuit packs in incorrect slots is prevented through circuit pack keying. The key mechanism is located on the faceplate latch, with an interference mechanism on the shelf.

As shown in Figure 4-6, the front of the shelf is covered with an EMC cover. If the shelf needs to be accessed for maintenance activities, the cover is hinged to drop down 180 degrees, or it can be easily removed by pulling out when at 45 degrees. The rear of the shelf is covered over the DS3 interface connectors and shelf cables. All covers are necessary to meet the EMC guidelines set by the FCC.

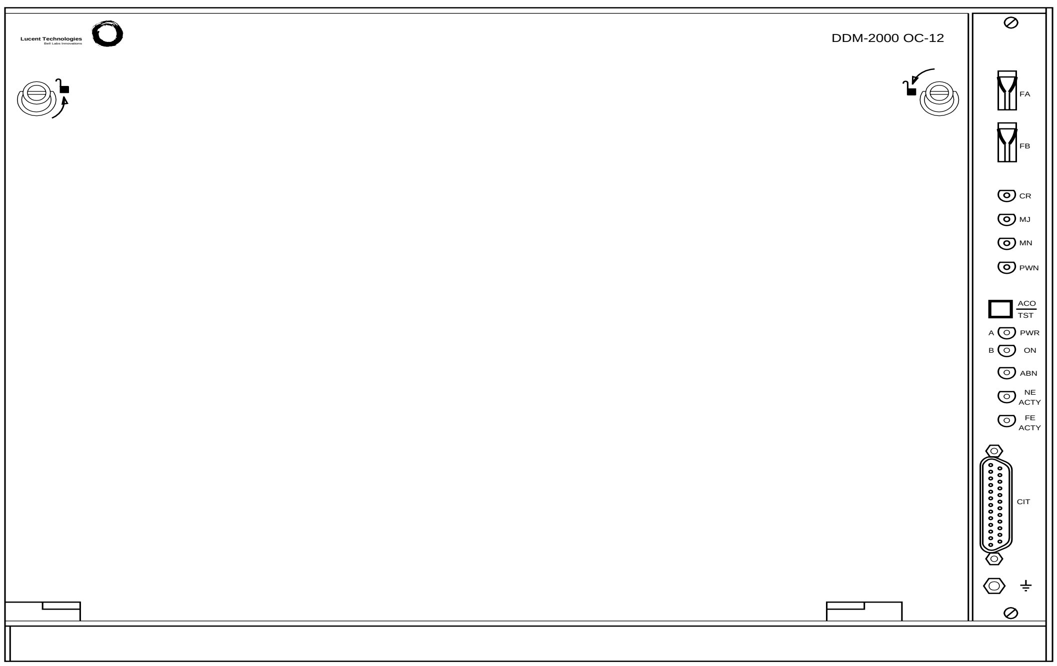


Figure 4-6. DDM-2000 OC-12 Front Panel

OC-12 Regenerator Shelf

Figure 4-7 shows the OC-12 Regenerator shelf configuration. The OC-12 Regenerator uses the same shelf unit as the OC-12 Multiplexer and includes up to four 23R-U regenerator (REGENR) circuit packs, a BBG5 system controller (SYSCTL) circuit pack, and a BCP1 overhead controller (OHCTL) circuit pack. Apparatus blanks and fans are not required. The OC-12 Regenerator shelf should be equipped with a baffle as shown in ED-8C727-10 for the DDM-2000 OC-12 Multiplexer shelf. The 23R-U circuit pack is classified discontinued availability (DA).

In Figure 4-7, the Main A and B shelf positions are equipped with four 23R-U REGENR circuit packs. This configuration supports two bidirectional OC-12 lines.

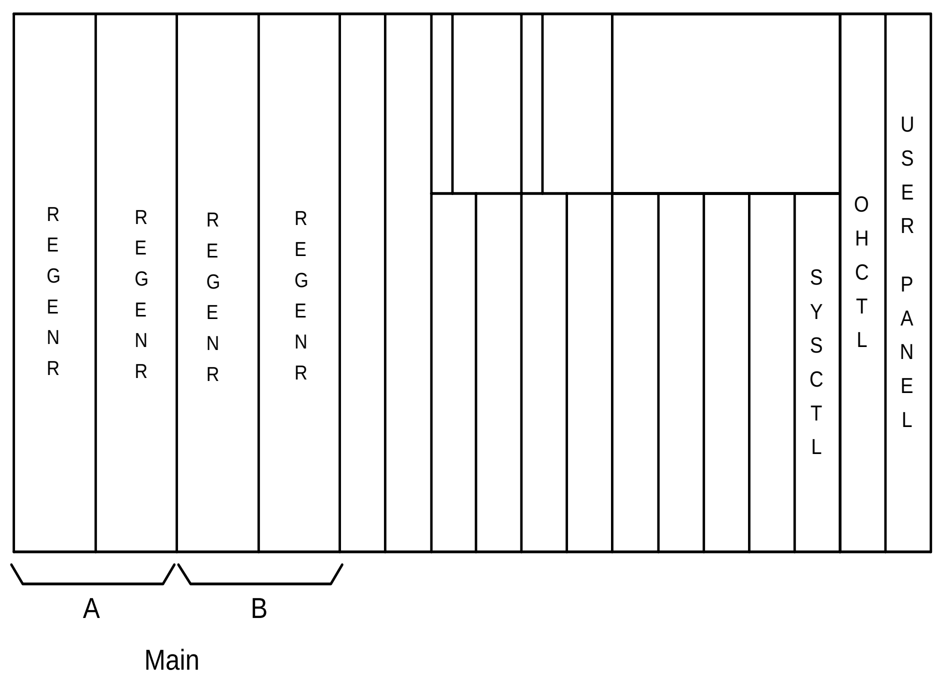


Figure 4-7. DDM-2000 OC-12 Regenerator Shelf

DDM-2000 Fan Shelf

The DDM-2000 Fan Shelf (Figure 4-8) provides forced convection cooling to DDM-2000 OC-12 shelves in controlled environments (central office (CO) and controlled environment vault).

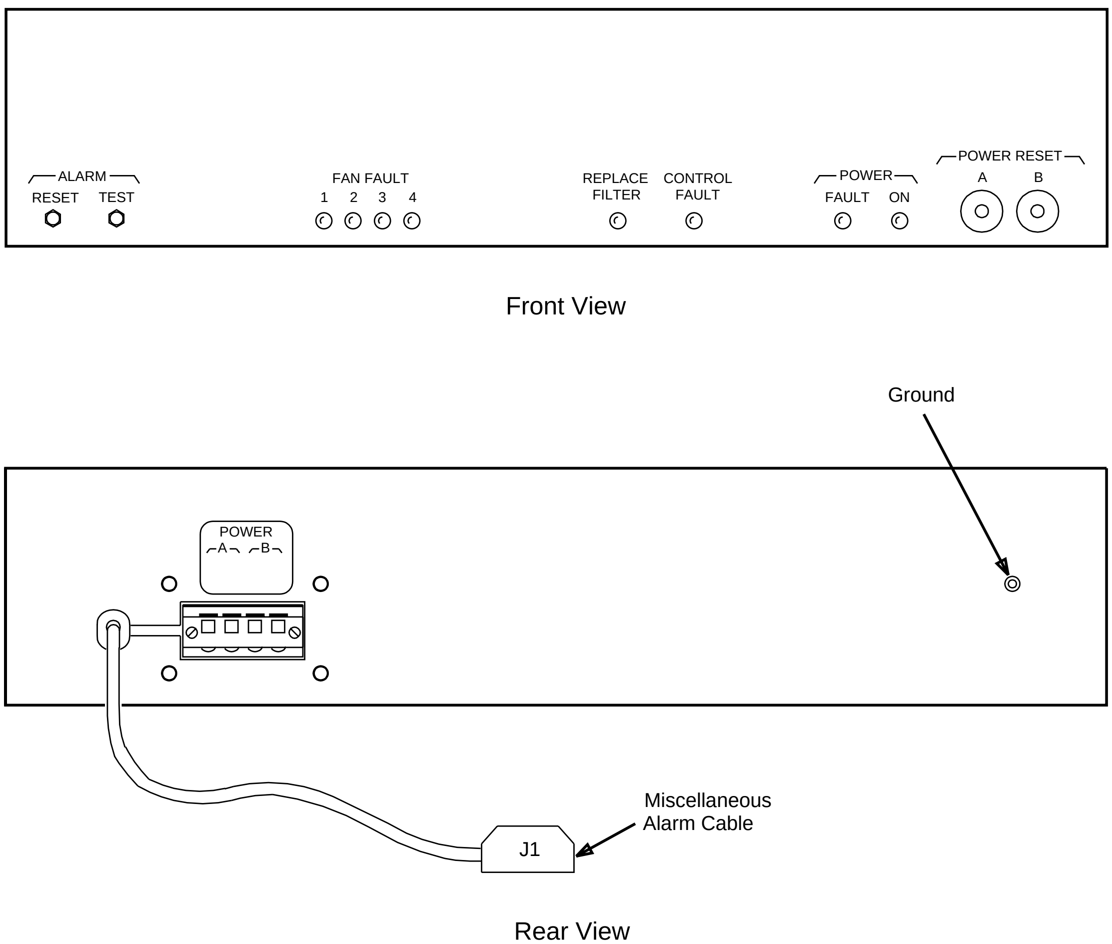


Figure 4-8. DDM-2000 Fan Shelf

The fan shelf is not required in DDM-2000 OC-3 Multiplexer applications in a controlled environment.

The fan shelf is required in all DDM-2000 OC-12 Multiplexer applications in a controlled environment. The fan shelf is not required in OC-12 Regenerator applications.

All applications should be equipped with a baffle as shown in ED-8C727-10 for the DDM-2000 OC-12 Multiplexer and OC-12 Regenerator shelves and ED-8C724-10 for the DDM-2000 OC-3 Multiplexer.

The Fan Shelf is 3.9 inches high by 9.3 inches deep by 21.2 inches wide and weighs 25 pounds. Mounting brackets can be attached in three positions to accommodate both front and rear access installations in different bay frames. The fan shelf is fully accessible from the front for service and maintenance.

DDM-2000 OC-3 and OC-12 Multiplexer Rings

Path Protection Switched Rings

The path protection switched ring has two single-fiber counter-rotating rings as shown in Figure 4-9. This architecture has distinct advantages over a linear architecture. Each node on the ring terminates four fibers: a transmit and receive fiber in each direction. Eight fibers are needed to connect the same network element (NE) in a nonterminal position of a linear add/drop 1+1 protected arrangement: two transmit and two receive in each direction, without providing the same level of protection that the ring provides. The architecture of the ring is designed to protect against any single point of failure, including a node failure, single fiber cut, or dual fiber cut. Node failure or dual fiber failure in a linear network affects traffic to all downstream nodes.

The signal that enters the ring is protected on a SONET path basis as switching is performed independently for each path. Because of the ring's unidirectional operation, time slots must be reserved all the way around the ring for all ring traffic, limiting the capacity of the ring to the OC-N line rate. The DDM-2000 OC-3 Multiplexer can provide both VT1.5 and/or STS-1 path protection, and the DDM-2000 OC-12 Multiplexer can provide STS-1 or STS-3c path protection. VT1.5 path protection is available at the OC-12 rate by using either a DDM-2000 OC-3 system colocated with a DDM-2000 OC-12 system or, for limited access[*], a 24G-U/24H-U or 29G-U/29H-U OC-12 OLIU in the OC-3 shelf.

* Any three STS-1s’ (24G-U/24H-U OLIU) or seven STS-1s’ worth of VT1.5s (29G-U/29H-U OLIU) of the 12 STS-1s in the ring traffic can be dropped from a DDM-2000 OC-3 shelf equipped with OC-12 OLIUs at this location, while the remaining STS-1s can continue on the ring.

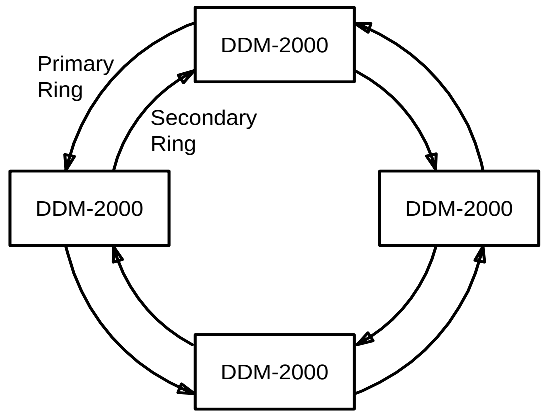


Figure 4-9. Two-Fiber Unidirectional Ring

Path-Protection Scheme

Path protection rings feed a SONET payload (STS or VT) from the ring entry point, simultaneously in both rotations of the ring, to the signal's ring exit point as shown by traffic AC and CA in Figure 4-10. The node that terminates the signal from the ring monitors both ring rotations and is responsible for selecting the signal that has the highest quality based on loss of signal (LOS), path alarm indication signal (AIS), and path bit error rate (BER) performance. On pass-through paths, all detected hard failures (loss of signal (LOS), loss of frame (LOF), loss of pointer (LOP), line alarm indication signal (AIS), STS-1 path AIS, or STS-1 path BER greater than 10^{-3}) will result in AIS insertion in the outgoing signals. This allows the terminating node to be aware of the failure and to switch to protection. Similarly, for dropped nonterminated paths, if both incoming STS-1s have any of the previous failures, AIS will be inserted in the dropped signal. The switching criteria also includes VT and STS-1 signal degrade (BER 10^{-5} and 10^{-8}). This feature allows higher quality transport services.

Under normal conditions, both incoming SONET path signals to the switch selection point will be of high quality, and the signal may be selected from either ring. A failure or a transmission degradation on one of the rings will require the other ring path to be selected, and this path selection will occur within 60 milliseconds after a hard failure condition. Figure 4-10 shows how traffic is switched when a dual-fiber cut occurs. The initial release of rings provides nonrevertive switching to give technicians the ability to verify the failure before a revertive switch occurs. A manual path protection switching command allows switching back to the original path for ease of ring maintenance.

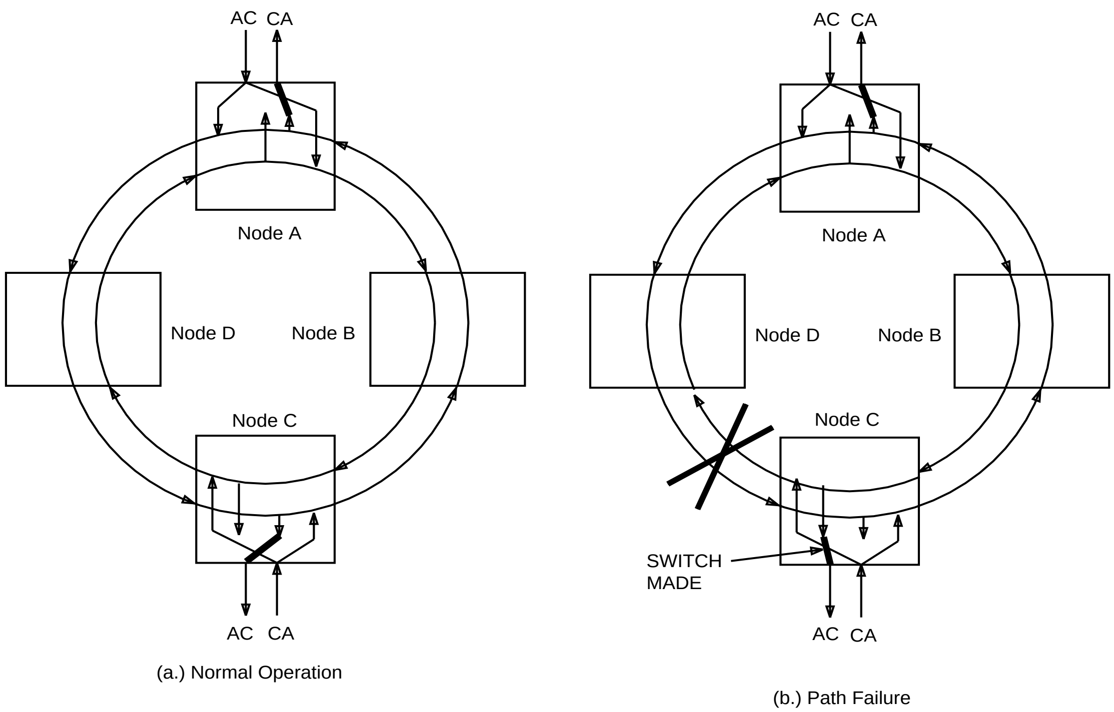


Figure 4-10. Ring Path Protection Switching

Dual Ring Interworking Concepts

As Figure 4-11 shows, dual ring interworking (DRI) allows a circuit (for instance, between nodes A and Z) with one termination in the upper ring and the other termination in lower ring to survive a failure of the shared node that is currently carrying service for the circuit. The failure is depicted by an "X" in the figure. The two shared nodes are Node B and Node C. Both nodes have the signal available to them at all times. When the failure occurs, the two terminating nodes and the two interconnect nodes switch so that traffic is now carried through Node C and around the node failure.

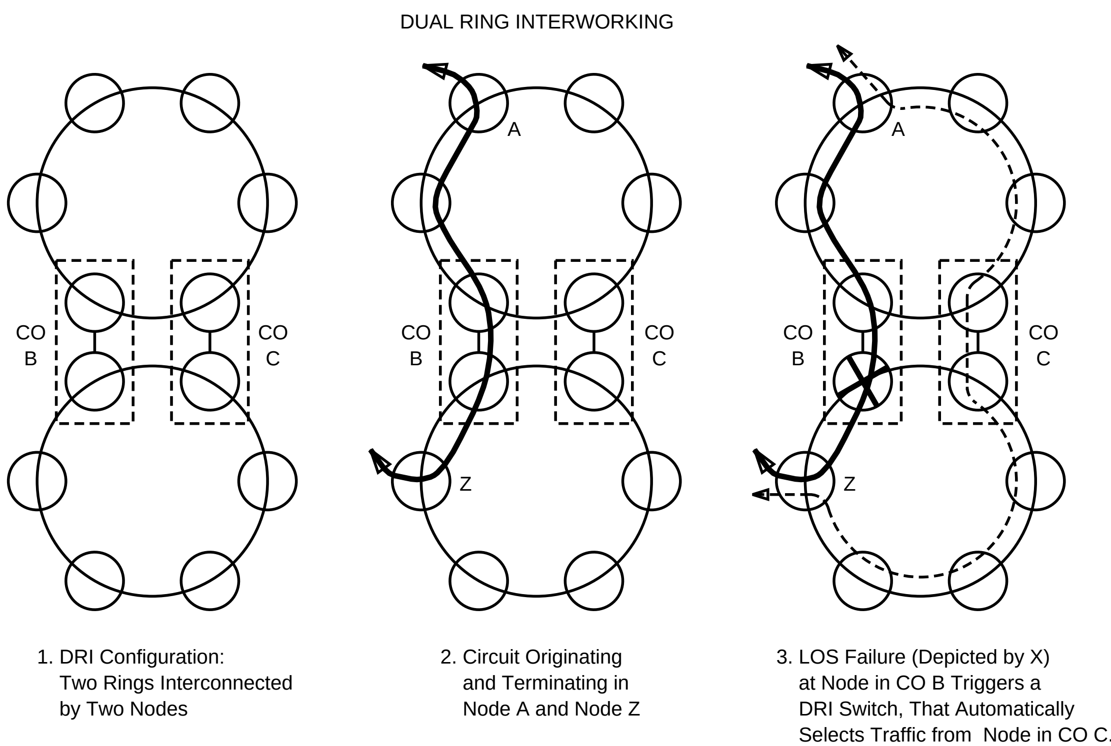


Figure 4-11. Dual Ring Interworking (DRI) Concepts

DRI Path Protection Scheme

Figure 4-12 shows DRI path protection switching. Note that the upper ring could be an FT-2000 bidirectional line switched ring. In the receive direction, a DRI node that passes a signal between rings performs two steps:

1. VT1.5 and/or STS-1 signals to be passed between rings are "dropped and continued." This means the signal is dropped at that node and simultaneously copied into the OC-3 signal in the outgoing direction of the same ring rotation.
2. The VT1.5 and/or STS-1 signal that was dropped in Step 1 and the corresponding VT1.5 and/or STS-1 signal incoming from the other ring direction are compared and the signal with the highest quality is selected. Quality is based on OC-3 LOS, STS-1 LOP, STS-1 AIS, VT1.5 LOP, and VT1.5 AIS. When the 22G-U, 22D-U, 24G-U/24H-U, or 29G-U/29H-U OLIU is used, VT1.5 ring path protection switching is also initiated when the VT1.5 signal BER has degraded to the point where it violates the user-settable switching threshold.

In the transmit direction, a DRI node feeds VT1.5 or STS-1 signals in the direction opposite to the "continue" portion of the drop and continue signal (Step 1 previously) to only one rotation of the ring as shown in Figure 4-12. This routing is to only one rotation as distinguished from how an ordinary path switched ring bridges incoming low-speed traffic onto both rotations.

The drop and continue disabled bridge routing necessary for DRI is established with a cross-connection command.

Hairpin Cross-Connections

In DDM-2000 OC-3 Release 9.0 and later for VT1.5 and Release 11.1/13.0 and later for STS-1, VT1.5/STS-1 signals from Function Units A or B can be cross-connected to VT1.5/STS-1 signals in Function Unit C. The VT1.5/STS-1 signals can be in any MXRVO, STS1E, or 22-type OLIU or 27G/27G2-U OLIU, except that MXRVO-to-MXRVO hairpins are not allowed.

See Section 5, "Operations, Administration, Maintenance, and Provisioning" for more information on cross-connections including hairpin cross-connections.

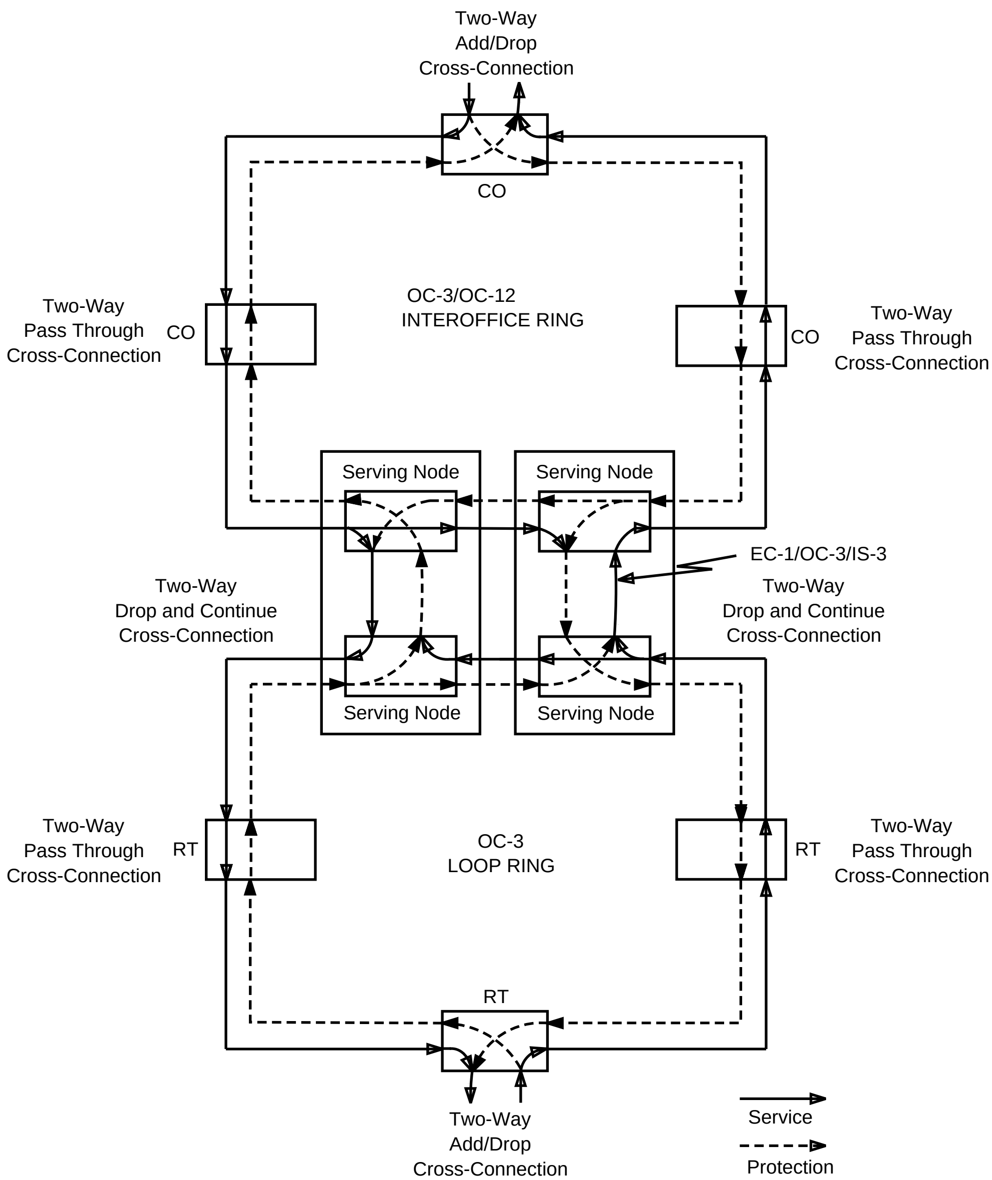


Figure 4-12. DRI Path Protection Switching

Transmission

DDM-2000 OC-3 Multiplexer

Interfaces and Multiplexing

Interfaces

The DDM-2000 OC-3 Multiplexer supports DS1 and DS3 low-speed interfaces, EC-1 low-speed and high-speed interfaces, OC-3 low-speed and high-speed interfaces, an OC-12 high-speed ring interface, OC-1 low-speed and high-speed interfaces, and an IS-3 interface. The DS1 and DS3 interfaces accept any DSX-1 or DSX-3 compatible signal (clear channel interfaces) and can be mixed on a per-STS-1 basis.

The EC-1 interfaces provide electrical interworking between DDM-2000 and other SONET equipment.

The IS-3 interface is a cost-effective optical interface for interconnecting co-located SONET equipment with multimode fiber. Except for differences in the optical specifications, the IS-3 interfaces (21D/21D-U and 22D-U OLIUs) are functionally equivalent to the OC-3 interfaces (21G/21G-U/21G2-U/21G3-U and 22G2-U/22G3-U/22G4-U OLIUs, respectively.

Terminal Configuration

Figure 4-13 is an overall block diagram of the DDM-2000 OC-3 Multiplexer in a terminal configuration. Internally, the OC-3 Multiplexer uses SONET standard multiplexing (refer to Appendix A). On the low-speed side, each group of 28 DS1 signals map into 28 asynchronous floating mode VT1.5 signals. The VT1.5 signals are combined into seven virtual tributary (VT) groups and then multiplexed to one STS-1 signal. A DS3 signal maps directly to an STS-1 signal via the asynchronous mapping. With the new TMUX circuit pack a DS3 can be demultiplexed into 28 DS1s before being mapped into VT1.5s and then into an STS-1. An EC-1 or OC-1 signal is converted to an STS-1 signal. Three internal STS-1 signals are multiplexed to an STS-3 signal and converted to an OC-3 optical signal.

In the opposite direction, a received OC-3 signal is converted back to an electrical STS-3 signal. The STS-3 signal is then demultiplexed to three STS-1 signals. DS3, EC-1, and OC-1 signals are recovered from their STS-1 signals, while a DS1-formatted STS-1 signal is demultiplexed to 7 VT1.5 groups and then to 28 VT1.5 signals.

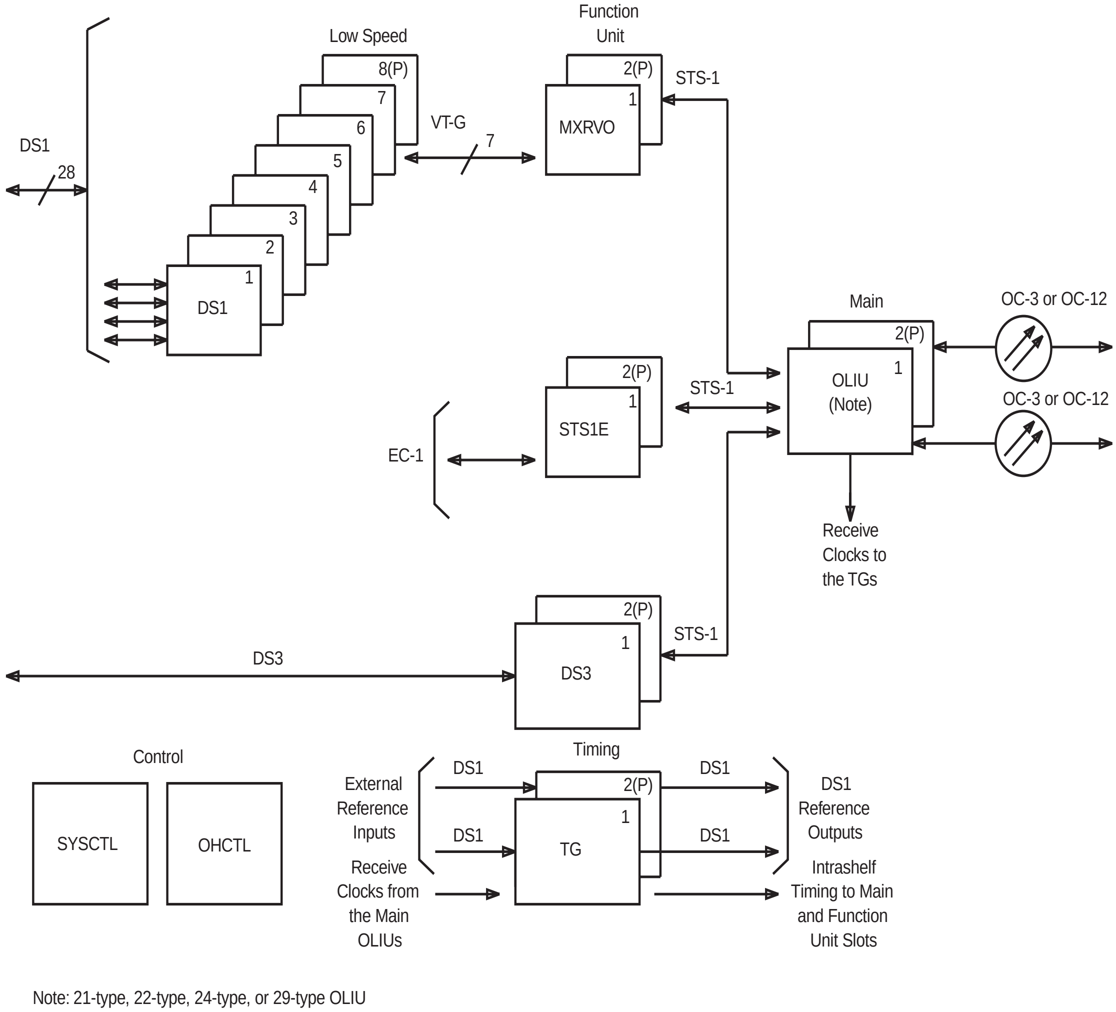


Figure 4-13. DDM-2000 OC-3 Multiplexer Block Diagram — Terminal

STS-1 Drop and Hubbing

With OC-3 interfaces installed in the Function Unit positions, the OC-3 Multiplexer can be configured for the STS-1 drop (Figure 4-14) and OC-3 hubbing (Figure 4-15) applications. STS-1 drop addresses linear network routes by sending through traffic directly from the OLIU circuit packs in the main positions to the OLIU circuit packs in the C Function Group positions. The hubbing application equips the B and/or A Function Groups with OLIU circuit packs in addition to the OLIUs used in the main and C groups for STS-1 drop. This allows multiple optical extensions from one shelf or a fiber hub as shown in Figure 4-15. In this application, STS-1 signals are routed between the main slots and the Function Group slots. For both STS-1 drop and hubbing applications, default STS-1 routing is provided based on circuit pack equipage with other routing options supported through provisioning.

To support OC-3 to OC-12 ring upgrades, and provide additional functionality for OC-12 rings, the OLIU provides all the 22-type OLIU VT1.5 TSI functionality on up to 3 STS-1s (24G-U/24H-U) or 7 STS-1s (29G-U/29H-U) in an OC-12 payload while residing in the DDM-2000 OC-3 shelf. The OC-12 optical interfaces are compatible with the DDM-2000 23G/23G-U and 23H/23H-U OLIUs, and up to any 3 or 7 STS-1s,depending on the OLIU used, from this payload may be dropped and cross-connected in the DDM-2000 OC-3 shelf without having to add a separate DDM-2000 OC-12 shelf. The 24G-U/24H-U or 29G-U/29H-U OLIU replaces the 22-type OLIU in the MAIN slot.

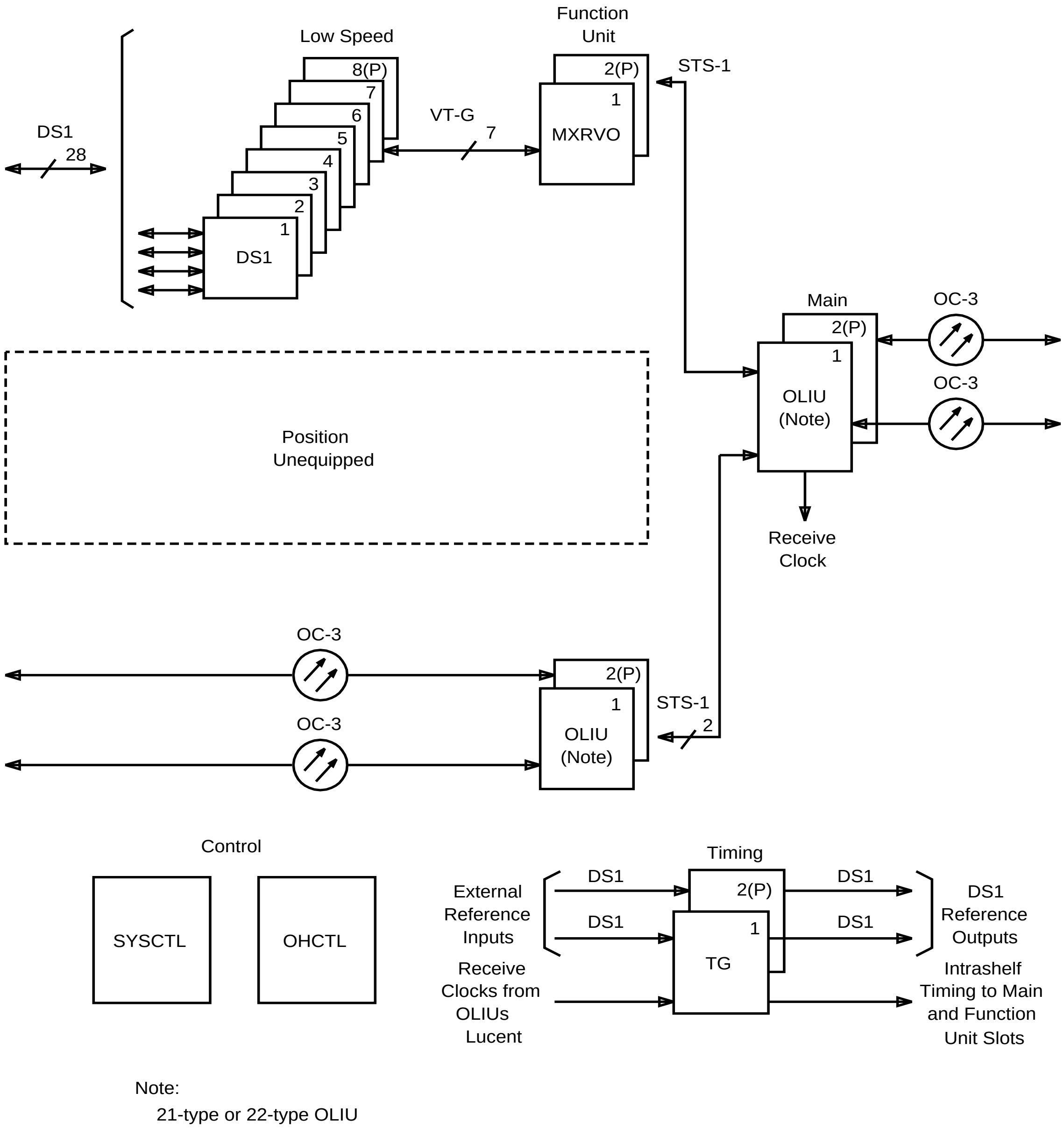


Figure 4-14. DDM-2000 OC-3 Multiplexer Block Diagram — STS-1 Drop

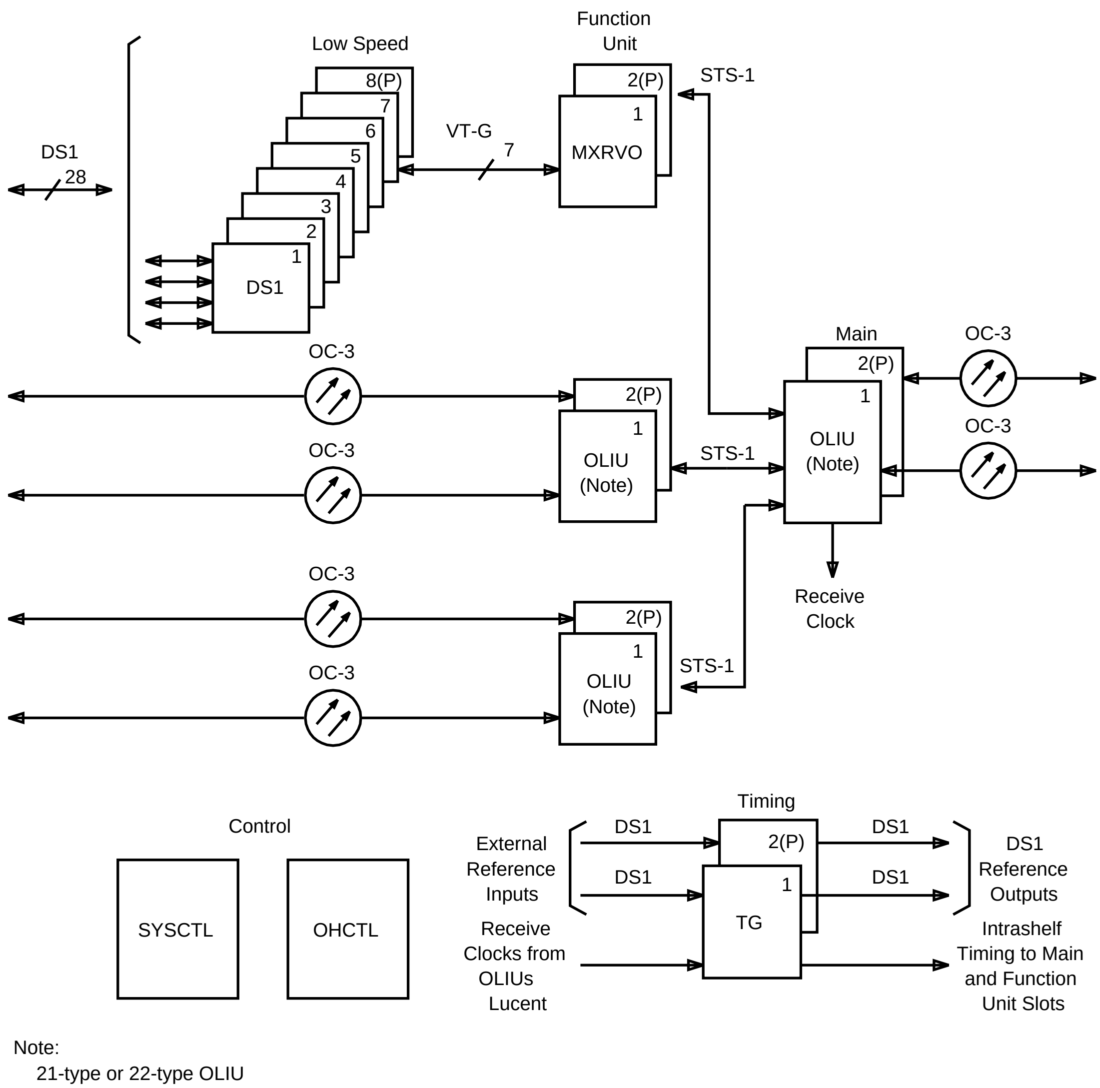


Figure 4-15. DDM-2000 OC-3 Multiplexer Block Diagram — Hubbing

Electrical Multiplexer

EC-1 electrical interfaces provide interworking between DDM-2000 OC-3 Multiplexers and other SONET systems. The EC-1 high-speed interface lets the DDM-2000 OC-3 Multiplexer function as a SONET electrical multiplexer (Figure 4-16) between 28 DS1 signals and an EC-1. This application is only applicable for Release 6 or 8 linear software.

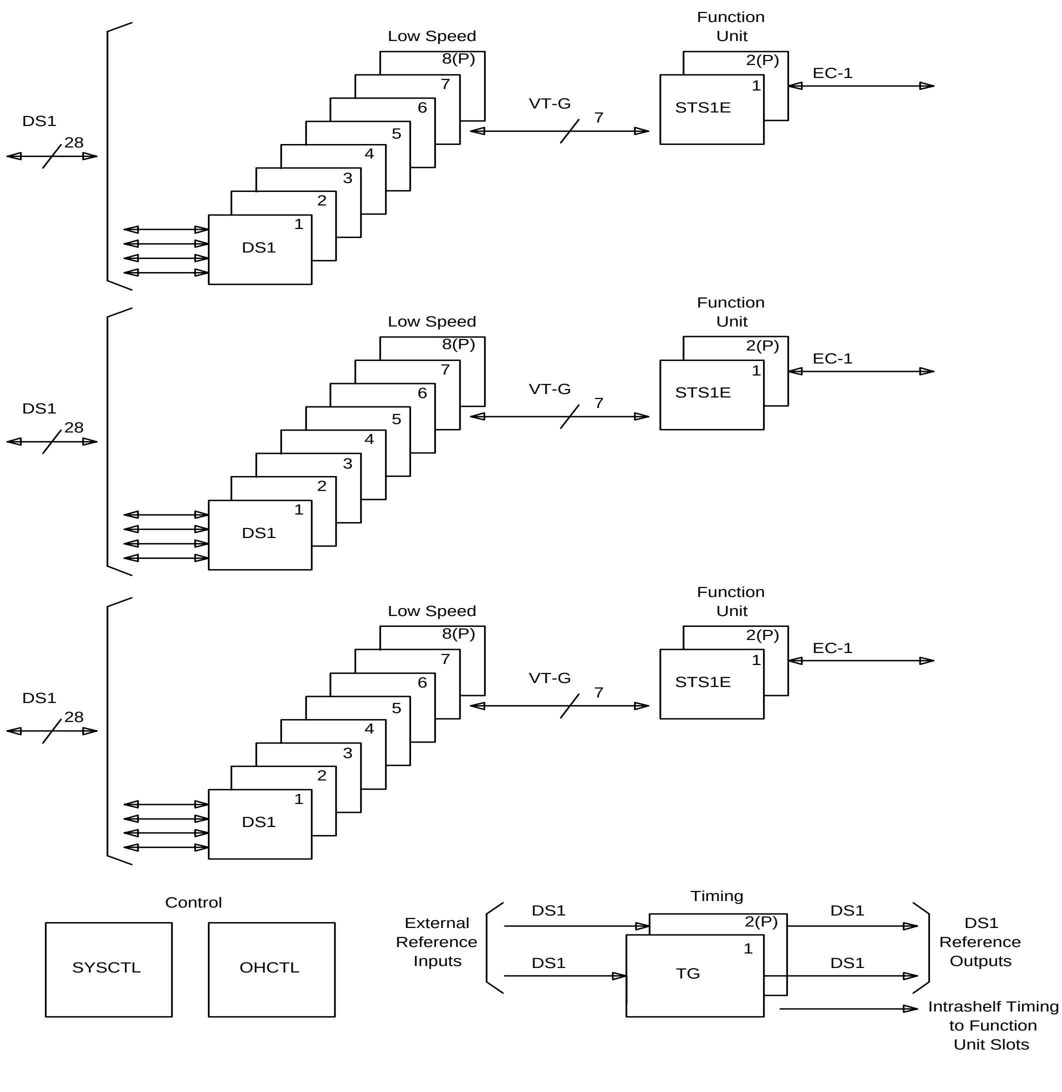


Figure 4-16. DDM-2000 OC-3 Multiplexer Block Diagram — SONET Electrical Multiplexer

DS1 Add/Drop and Path Switched Rings

For the DS1 add/drop and ring (Figure 4-17) application, the TSI feature of the 22-type OLIUs and the 24G-U24H-U and 29G-U/29H-U OLIU (ring only) provides full flexibility in selecting traffic for each DS1, DS3, or EC-1 low-speed port from any high-speed time slot. The TSI function supports cross-connections across the full bandwidth of each OC-3 interface as well as to any low-speed port.

Figure 4-17 is a block diagram of the DDM-2000 OC-3 Multiplexer VT1.5/STS-1 path switched ring application. The DDM-2000 OC-3 Multiplexer interfaces to the ring through the Main slots at the OC-3 rate and uses the programmable VT1.5/STS-1 TSI capability. Path switching can be done on VT1.5 paths, STS-1 paths, or a mixture of these. Up to 84 DS1s, 3 DS3s, 3 EC-1s, 1 OC-3/IS-3 1+1 linear optical extensions, 0x1 optical extensions or equivalent combination can be added/dropped from the DDM-2000 OC-3 Multiplexer self-healing ring at any node. Because of the ring's path protection scheme, time slots must be reserved all the way around the ring for all ring traffic. For 22-type OLIUs this limits the capacity of the ring to OC-3 line rates. However, the 24-type OLIUs support OC-12 rings with a maximum of three and the 29-type OLIUs support OC-12 rings with a maximum of seven of the 12 STS-1s accessed at any node. Like the add/drop topology, the TSI feature in the 29G-U/29H-U OLIU offers full flexibility in assigning signals between low-speed DS1, DS3, EC-1 or OC-3 ports and the high-speed interface at each shelf.

The DDM-2000 OC-3 Multiplexer DRI application uses the same shelf configuration as the OC-3 path switched ring (Figure 4-17). The main difference is that the VT1.5/STS-1 paths desired for DRI should be provisioned for drop and continue. As with the VT1.5/STS-1 path switched ring, path selection is at the VT1.5/STS-1 level. The DDM-2000 OC-3 and OC-12 Multiplexer path switched ring architecture allows mixing of drop and continue circuits with standard path switched circuits. TSI flexibility is also maintained in the assignment of low-speed ports to the high-speed interface.

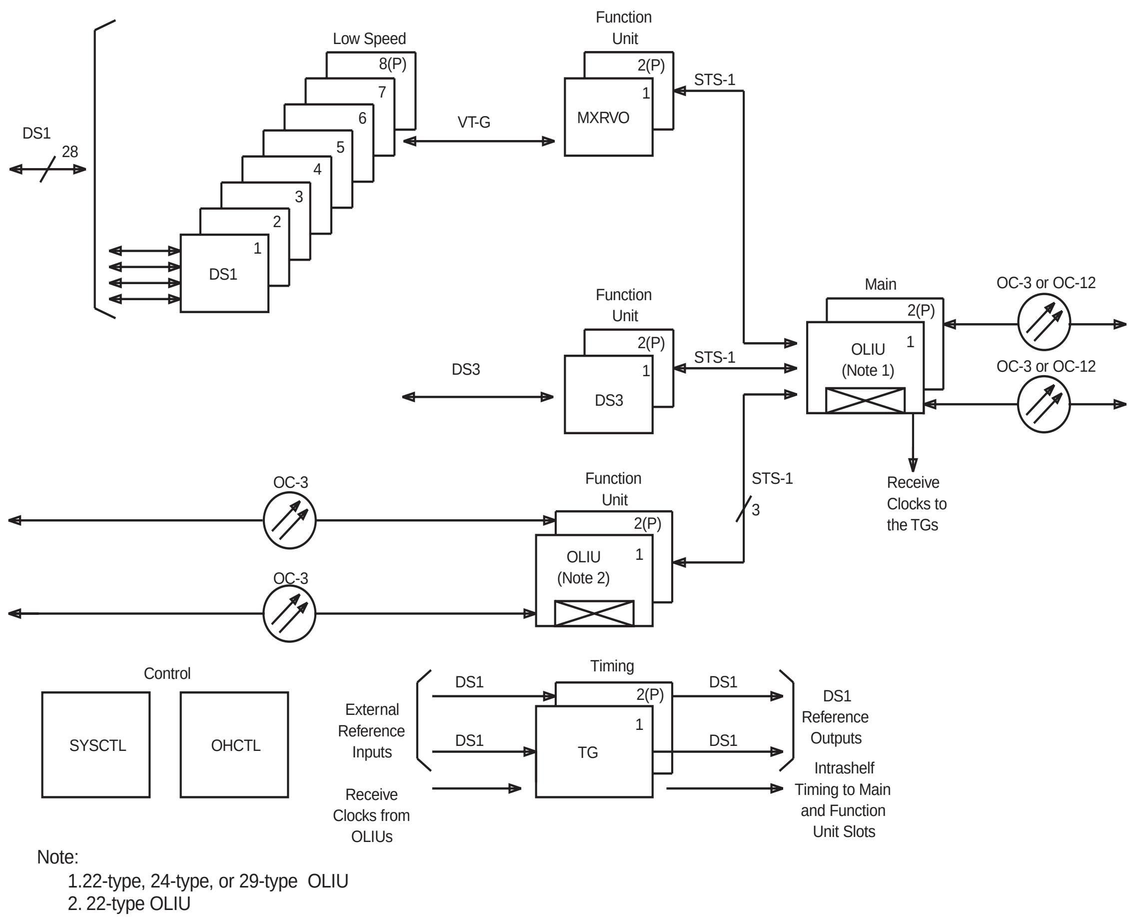


Figure 4-17. DDM-2000 OC-3 Multiplexer Block Diagram — DS1/DS3/ EC-1 Add/Drop and VT1.5/STS-1 Path Switched Ring

Figure 4-18 is an overall block diagram of the DDM-2000 OC-3 Multiplexer in a terminal configuration. In this case, however, 24G-U/24H-U or 29G-U/29H-U OLIUs are installed in Main providing OC-12 optics in an OC-3 shelf.

The 24G-U/24H-U or 29G-U/29H-U OLIU receives an OC-12 signal and converts it to an electrical STS-12. This STS-12 is then demultiplexed into 12 STS-1 signals with the capability of routing up to any three (24-type OLIU) or seven (29-type OLIU) of these 12 STS-1s to the Function Unit slots. The STS-1s that are dropped can contain any combination of VT-G, EC-1, or DS3 signals routed to the Function Units. The remaining STS-1s continue on the OC-12 ring.

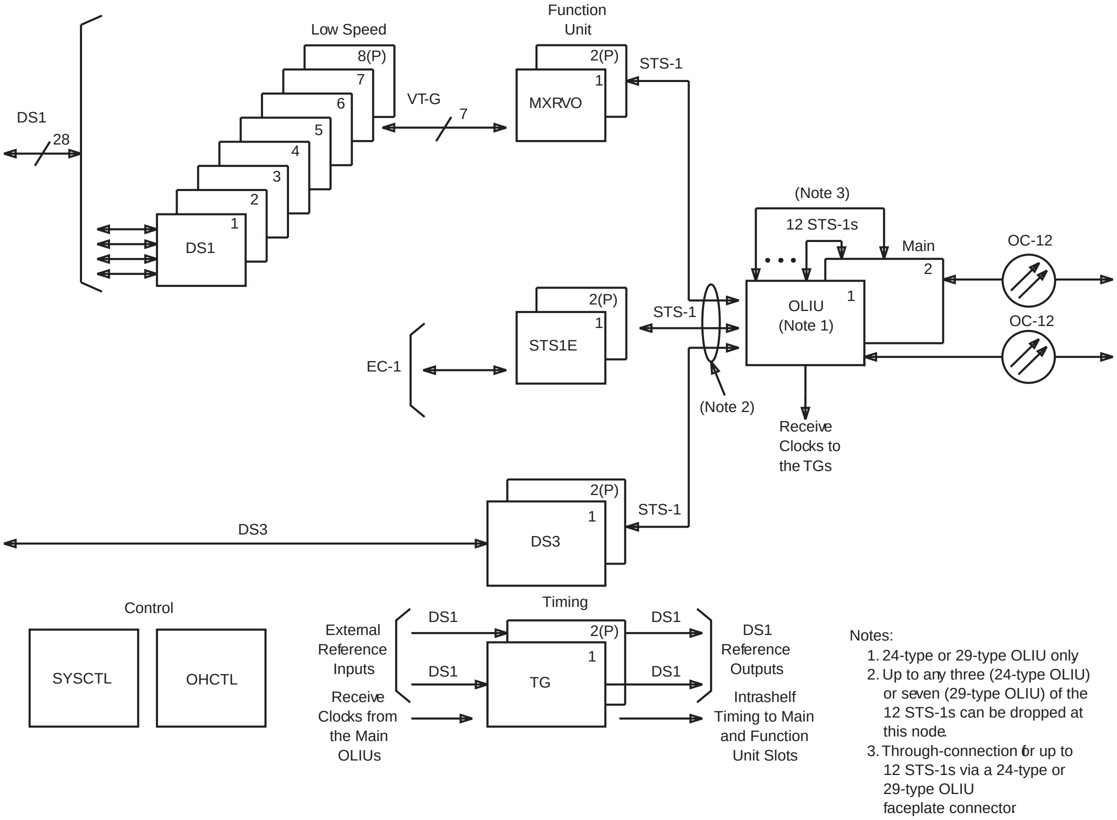


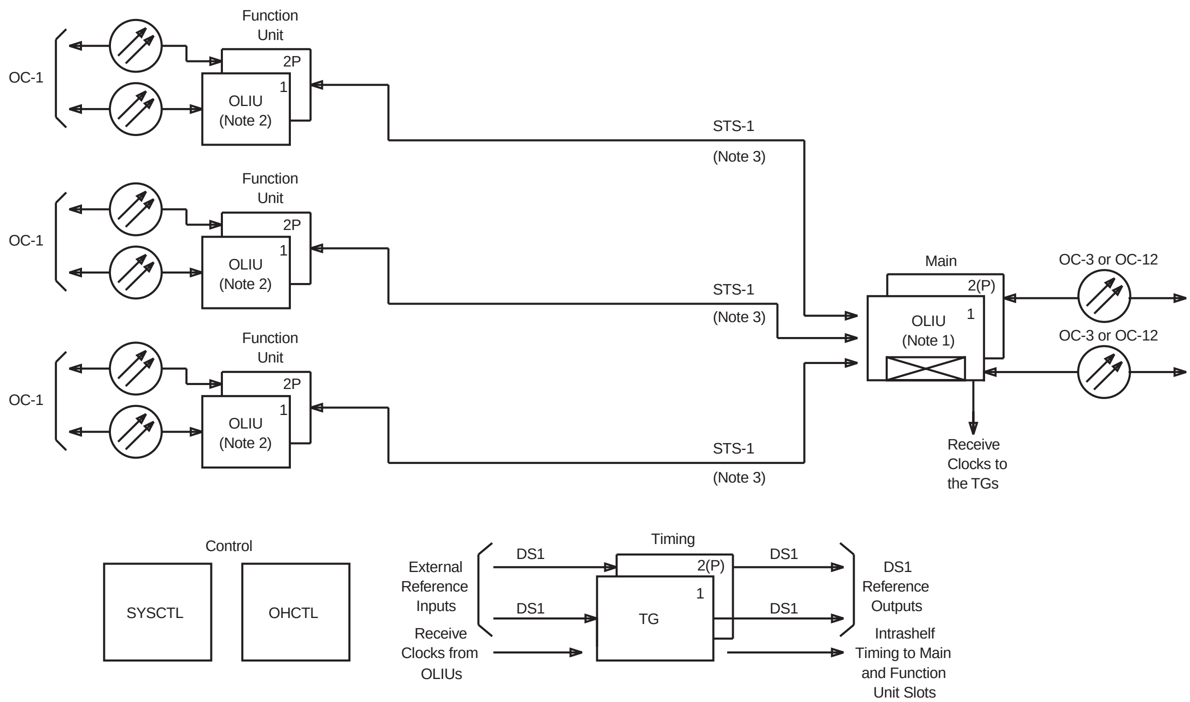
Figure 4-18. DDM-2000 OC-3 Multiplexer with OC-12 Optics Block Diagram

FiberReach Host

Figure 4-19 is a block diagram of the DDM-2000 OC-3 Multiplexer serving as a DDM-2000 FiberReach host. Dual OC-1 interfaces provided by the 27G-U and 27G2-U OLIUs can be equipped in the Function Unit slots to support single-homing and dual-homing applications. The 27G-U/27G2-U can also be equipped in the main slots to support stand-alone applications.

Figure 4-19 shows a single-homing arrangement with two 27G-U or 27G2-U OLIUs in the Function Unit slots. Each OLIU supports one direction (transmit and receive) of two independent OC-1 rings for a total termination capacity of six OC-1s. Each OC-1 has the capacity of up to 28 VT1.5s, but the total capacity of the shelf can not exceed 84 DS1s or three STS-1s.

See the 27G-U/27G2-U OLIU circuit pack description in this section for more information on this operation.



Notes:

1. 22-type, 24-type, or 29-type OLIU.
2. 26G2-U or 27-type OC-1 OLIU.One direction of two independent OC-1 rings.
3. One or two STS-1s. Shelf capactiy is 3 STS-1s (84 DS1s).

Figure 4-19. DDM-2000 OC-3 Multiplexer Block Diagram — DDM-2000 FiberReach Host — Single Homing

FiberReach Stand-Alone Host

Figure 4-20 is a block diagram of the DDM-2000 OC-3 Multiplexer serving as a DDM-2000 FiberReach stand-alone host. Dual OC-1 interfaces provided by the 27G-U and 27G2-U OLIUs can be equipped in the main slots to support this application.

Figure 4-20 shows a stand-alone arrangement with two 27G-U or 27G2-U OLIUs in the main slots. Each OLIU supports one direction (transmit and receive) of two independent OC-1 rings for a total termination capacity of two OC-1s. Each OC-1 has the capacity of up to 28 VT1.5s.

See the 27G-U and 27G2-U OLIU circuit pack descriptions in this section for more information on this operation.

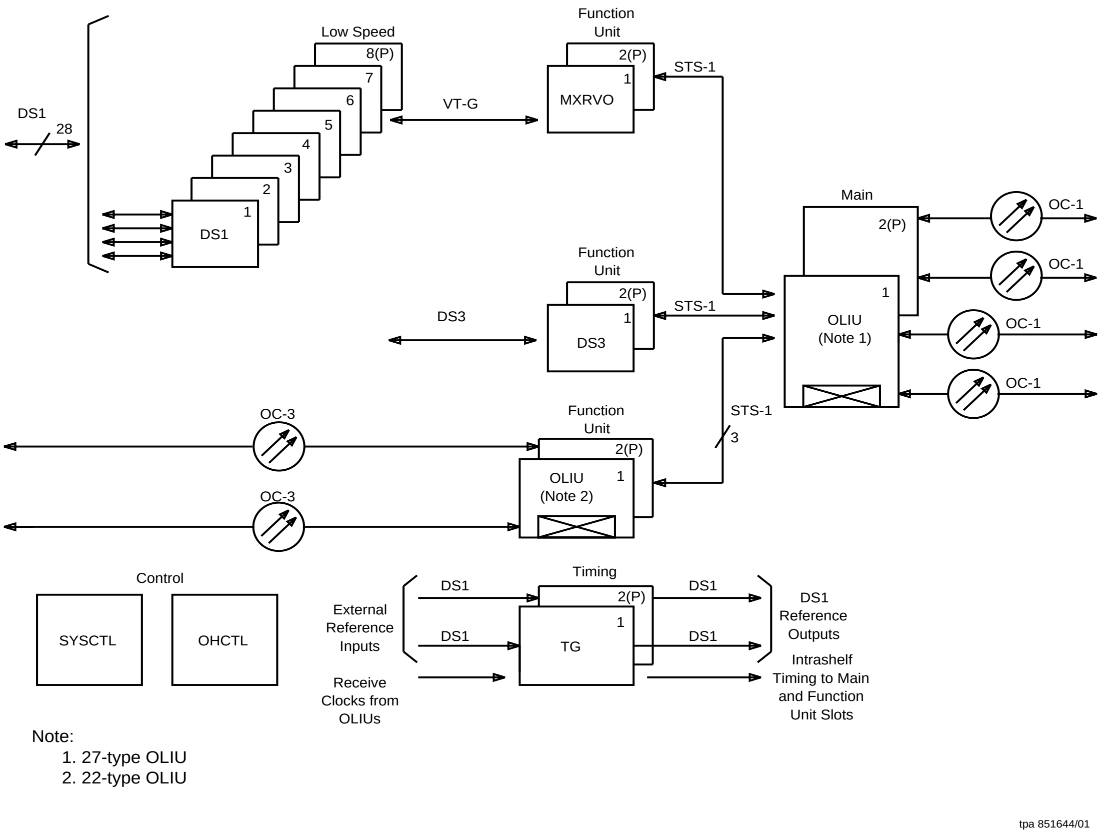


Figure 4-20. DDM-2000 OC-3 Multiplexer Block Diagram - FiberReach Stand-Alone Host Configuration

Repeater

The DDM-2000 OC-3 Multiplexer can be provisioned as an OC-3/OC-3c repeater (Figure 4-21). This configuration provides a simple, cost effective method for extending an OC-3 line. This application is only applicable for Release 6 or 8 linear software.

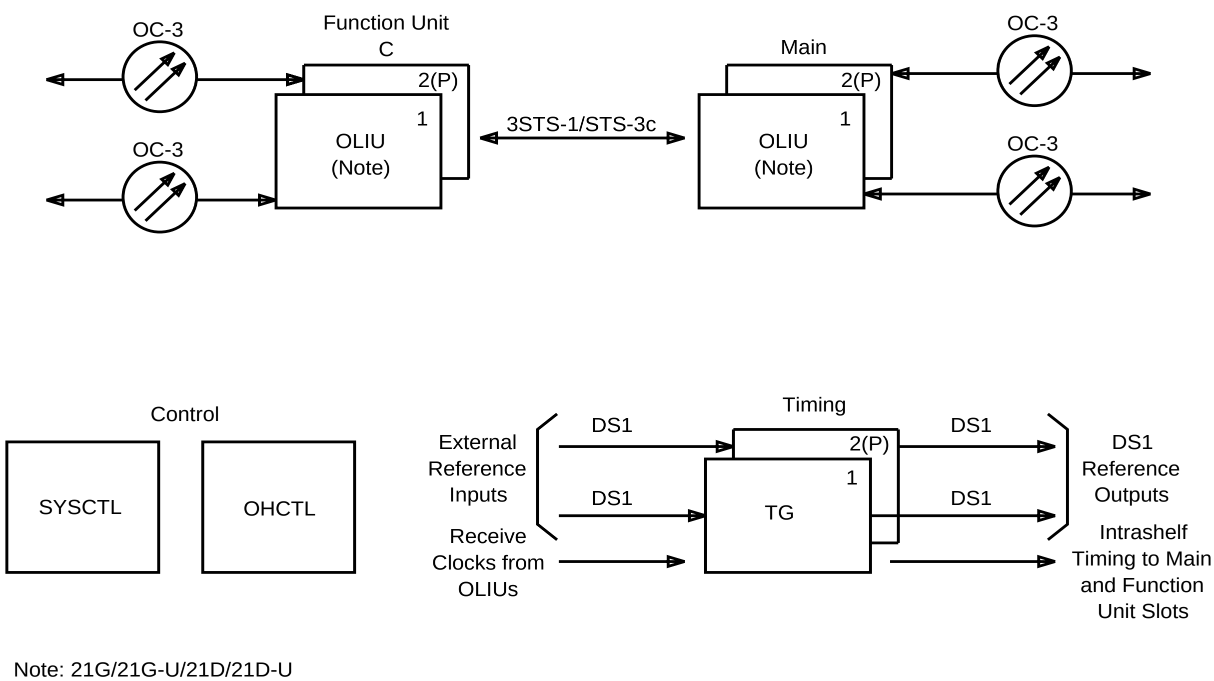


Figure 4-21. DDM-2000 OC-3 Multiplexer Block Diagram — OC-3/OC-3c Repeater

Electrical Interface Circuit Packs

BBF1B DS1 and BBF3/BBF3B DS1 Low-Speed Interface (DS1PM)

The BBF1B DS1 circuit pack provides an interface between four DS1 signals and a DDM-2000 OC-3 Multiplexer.

In the transmit direction, the DS1 circuit pack accepts four DS1 signals from a DSX-1 panel (or equivalent). The DS1 signals can have alternate mark inversion (AMI) or bipolar 8-zero substitution (B8ZS) coding. DS1 signal coding is assigned on a per-DS1 basis. The four incoming DS1 signals are mapped into standard floating mode, asynchronous VT1.5 signals with VT path overhead. The four VT1.5 signals are then multiplexed into one VT-G signal that is sent to the multiplexer or STS1E circuit pack.

In the receive direction, a VT-G signal is received from the multiplexer or STS1E circuit pack and demultiplexed into four VT1.5 signals. Each VT1.5 signal is passed through circuitry to interpret VT pointers and access path overhead. The DS1 payload is then extracted from each VT1.5 and transmitted to the DSX-1 panel.

The BBF3/BBF3B DS1PM circuit pack performs all of the same transmission functions as the DS1 circuit pack, and in addition, performs DS1 path performance monitoring (PM). Near-end performance monitoring data is collected from incoming DS1 signals (arriving from the DSX-1) in either extended superframe (ESF) or superframe (SF) formats. For ESF-formatted DS1s, the DS1PM circuit pack also reads the embedded ESF data link to collect far-end performance information. See Section 3, "Applications," for more information on DS1PM applications. Any combination of DS1 and DS1PM circuit packs can be equipped within each of the three low-speed groups of the DDM-2000 OC-3 Multiplexer. If one or more DS1PM circuit packs are used in a low-speed group and DS1 low-speed protection is desired, the protection slot for that group must be equipped with a DS1PM circuit pack.

BBF6 T1 Extension (T1EXT)

The BBF6 T1 Carrier Extension (T1EXT) circuit pack provides an interface to two T1 carrier signals. In the transmit direction, the T1EXT circuit pack accepts two T1 signals from a patch panel (or equivalent). The T1 signals can have AMI or B8ZS line coding. The line coding is assigned on a per-T1 basis. The two incoming T1 signals are mapped into a standard, floating mode, asynchronous VT1.5 signal with VT path overhead. The two VT1.5 signals are then multiplexed into one VT-G signal that is sent to the OLIU circuit pack.

In the receive direction, a VT-G signal is received from the OLIU circuit pack and demultiplexed into two VT1.5 signals. Each VT1.5 signal is passed through circuitry to interpret VT pointers and access path overhead. The DS1 payload is then extracted from VT1.5 signal and transmitted to T1 carrier.

Each T1 carrier loop is also supplied with simplex power with a 60 mA constant current. The T1EXT circuit pack performs DS1 path performance monitoring on each T1. Near-end performance data is collected from incoming T1 signals (arriving from T1 loop) in either extended super frame (ESF) or superframe (SF) formats. For ESF-formatted T1s, the circuit pack also reads the embedded ESF data link to collect far-end performance information. A T1EXT circuit pack can be configured for 1X7 protection, provided that the protection slot is equipped with an identical circuit pack. The T1EXT circuit pack requires that both companion FUNCTION UNITS slots be equipped with BBG2B MXRVO circuit packs. An external lightning and surge protection assembly is required with the T1 configuration for outside plant applications. For each BBF6 circuit pack used in an outside plant application, two LPROT lightning protection cards should be used in the lightning and surge protection assembly. Refer to Chapter 6, "System Planning and Engineering," for specific engineering rules regarding T1 extensions.

BBF8 High bit rate Digital Subscriber Line (HDSL)

The BBF8 HDSL circuit pack provides for HDSL interface capability on the DDM-2000 OC-3 shelf. It allows the transport of T1 payloads, for up to 12,000 feet, over two metallic 24 AWG twisted-pair lines. Data is transported over each pair bidirectionally using echo cancellation techniques.

In the transmit direction, the HDSL circuit pack performs an inverse multiplexing function which splits the DS1 payload into two 784 Kb/s data streams. These signals are then transmitted over two twisted-pair lines using a 2B1Q line code. At the receiving PairGain™ HDSL equipment* will combine the two data streams to reconstruct the original DS1 payload.

In the receive direction, the HDSL circuit pack combines the two 784 Kb/s data streams back into the original DS1. The signal is then sent through normal multiplexing operations to the SONET level.

The BBF8 fits into the low-speed slot and provides two, four-wire HDSL interfaces. Each interface provides a full DS1 payload capacity mapped to a SONET VT1.5. As with the DS1 circuit packs, an MXRVO must be used to perform VT cross-connect functions into an STS-1. Once in SONET, the DS1 payload is treated as a normal DS1.

The HDSL circuit pack supports both the HDSL and DDM-2000 management domain. DDM-2000 management can perform DS1 loopback functions, tests and alarm reporting through the SONET DCC or DDM-2000 CIT access. The HDSL

* For more information contact:
PairGain Technologies
14402 Franklin Avenue
Tustin, CA 92780-7013
Customer Service # 1-800-638-0031

management domain, available only through a BBF8 faceplate RS-232 port, can perform all these functions plus provide performance monitoring and history reporting. For each BBF8 circuit pack used in an outside plant application, two LPROT lightning protection cards should be used in the lightning and surge protection assembly. Refer to Chapter 6, "System Planning and Engineering," for specific engineering rules regarding T1 extensions.

BBG4/BBG4B DS3 Low-Speed Interface (DS3)

The BBG4/BBG4B DS3 low-speed interface circuit pack provides a mapping between the DS3 low-speed signal and an internal STS-1 signal.

In the transmit direction, the incoming DS3 signal can be either formatted or unformatted (clear channel). The BBG4/BBG4B DS3 circuit pack accepts one 44.736 Mb/s bipolar 3-zero substitution (B3ZS) coded DS3 signal from the rear connector. The incoming DS3 signal is mapped into an STS-1 payload envelope using SONET asynchronous mapping. The STS-1 path overhead and pointer bytes are added and the resulting signal is sent to the high-speed OLIU circuit pack.

In the receive direction, the STS-1 signal from the OLIU circuit pack goes through STS-1 pointer interpretation, and path overhead is removed and processed.

After the DS3 signal is recovered from the STS-1 payload envelope, the DS3 performance bits (P-bits) may be monitored and corrected through a provisionable violation, monitor, and removal (VMR) function.

The BBG4B DS3 circuit pack provides enhanced DS3 performance monitoring capabilities with software releases 7.2 and later. The BBG4B is backward compatible with the BBG4.

BBG19 DS3 Data Services Interface (DS3)

The BBG19 DS3 Data Services Interface circuit pack provides a mapping between a DS3 low-speed signal from a DS3 Data Services Device and an internal STS-1 signal.

In the transmit direction, the incoming DS3 signal can be either formatted or unformatted (clear channel). The BBG19 DS3 circuit pack accepts one 44.736 Mb/s bipolar 3-zero substitution (B3ZS) coded DS3 signal through the faceplate connector (0x1 connection). The incoming DS3 signal is mapped into an STS-1 payload envelope using SONET asynchronous mapping. The STS-1 path overhead and pointer bytes are added and the resulting signal is sent to the high-speed OLIU circuit pack.

In the receive direction, the STS-1 signal from the OLIU circuit pack goes through STS-1 pointer interpretation, and path overhead is removed and processed.

After the DS3 signal is recovered from the STS-1 payload envelope, the DS3 performance bits (P-bits) may be monitored and corrected through a provisionable violation, monitor, and removal (VMR) function.

The BBG19 DS3 circuit pack provides enhanced DS3 performance monitoring capabilities with software releases 11.0 and later.

BBG20 DS3 Transmux (TMUX)

The BBG20 DS3 Transmux interface circuit pack (TMUX) provides a mapping between the DS3 low-speed signal and internal STS-1 signals.

In the transmit direction, the BBG20 TMUX circuit pack accepts one 44.736 Mb/s bipolar 3-zero substitution (B3ZS) coded DS3 signal and demultiplexes it into 28 DS1s. Performance monitoring is performed on the DS1s before they are mapped into floating VT1.5s. The 28 VT1.5s are then multiplexed into STS-1 payload envelope(s) using SONET asynchronous mapping. The STS-1 path overhead and pointer bytes are added and the resulting signal is sent to the high-speed OLIU circuit pack.

In the receive direction the reverse process takes place: The STS-1 signal(s) from the OLIU circuit pack go through STS-1 pointer interpretation, path overhead is removed and processed, and the twenty-eight VT1.5s are stripped of their overhead to produce 28 DS1s. The DS1s are then multiplexed back into the DS3.

The DS3 can be either an M13 or C-bit parity formatted signal. The BBG20 TMUX circuit pack provides enhanced DS3 performance monitoring capabilities with software releases 13.0, 11.1, and later, in addition to DS1, VT, and STS-1 PM.

BBF9/BBF10 LAN Interface (LAN)

The electrical BBF9 LAN circuit pack 10/100 BaseT or the optical BBF10 LAN circuit pack 100Base FX provides an interface for 802.3 compliant LAN signals.

In the transmit direction, the BBF9 accepts electrical or the BBF10 accepts optical LAN signals (MAC frames) and converts them into AAL5 Protocol Data Units (packets) which are mapped into ATM cells, and distributed over 1 to 8 DS1 channels using the ATM Forum specification for ATM inverse multiplexing (IMA). Each DS1 channel is mapped into a SONET VT1.5 channel for transmission through the SONET network. In the receive direction the circuit pack performs the reverse process to convert ATM cells to MAC frames for forwarding to the LAN interface.

Each BBF9 or BBF10 LAN circuit pack uses two adjacent LOW SPEED slots and there is no equipment protection provided. However, either VT1.5 or STS-1 ring path switching is available. The BBG2B MXRVO circuit pack allows three LAN circuit packs in the LOW SPEED GROUP slots and the BBG2 MXRVO allows two LAN circuit packs in the LOW SPEED GROUP slots. A maximum of three LAN

circuit packs are allowed per LOW SPEED GROUP, but no more than six per shelf due to cabling limitations. Both FUNCTION UNITS slots must be equipped with MXRVO circuit packs. Mixing with DS1, DS1PM, or T1EXT circuit packs is allowed within the same LOW SPEED GROUP.

BBG6 EC-1 Interface (STS1E)

The BBG6 STS1E circuit pack provides high- and low-speed EC-1 interfaces for interworking with other SONET products.

In the high-speed mode (only available with linear software releases), the STS1E circuit pack provides multiplexing of the seven VT-G signals from the DS1 low-speed circuit pack to the EC-1 rate (51.84 Mb/s). In the transmit direction, SONET transport and STS-1 path overhead is provided on the EC-1 signal, the signal is scrambled and B3ZS coding inserted. A data communications channel (DCC) is not available because of the SONET overhead byte limitation imposed by the T1.105 standard definition of the EC-1 interface. In the receive direction, B3ZS coding is removed and the EC-1 signal is descrambled. The resulting STS-1 from the EC-1 signal goes through STS-1 pointer interpretation and the path overhead is removed and processed. The seven VT-G signals are recovered and sent to the DS1 circuit packs.

In the low-speed mode, the STS1E circuit pack receives an EC-1 signal, removes B3ZS coding, descrambles the signal, and sends the resulting STS-1 signal to the OLIU for transmission at the OC-3 rate. Likewise, in the other direction, the STS-1 signal from the OLIU is converted to an EC-1 signal.

BBG2/BBG2B VT to STS-1 Multiplexer (MXRVO)

The VT to STS-1 multiplexer BBG2/BBG2B MXRVO circuit pack multiplexes between seven VT-G signals from the DS1 circuit packs and one STS-1 signal.

In the transmit direction, the MXRVO circuit pack receives one VT-G signal from each of the seven DS1 circuit packs. The seven VT-G signals are mapped into one STS-1 payload envelope. The STS-1 path overhead and pointer bytes are added and the signal is sent to the OLIU circuit pack.

In the receive direction, the STS-1 signal from the OLIU circuit pack goes through STS-1 pointer interpretation, and the path overhead is removed and processed. The seven VT-G signals are recovered from the STS-1 payload envelope for transmission to the DS1 circuit packs.

The BBG2B MXRVO circuit pack is required for use with the BBF6 T1EXT circuit pack. The BBG2B MXRVO provides -48V to the BBF6 T1EXT circuit packs. The BBG2 MXRVO does not. The BBG2/BBG2B MXRVO circuit packs are also required for use with the LAN circuit packs.

Optical Interface Circuit Packs

Table 4-3 lists the DDM-2000 OLIU Feature Summary.

Table 4-3. DDM-2000 OLIU Feature Summary

OLIU	Line Rate (Mb/s)	Span Length (Km)	VT/STS Signal Degrade PS	TSI	Fiber Type	Ext. Atten.	System	See Note
21D	155.52	< 3	No	STS-1/STS-3c	MM	No	OC-3/OC-12	4
21D-U	155.52	< 3	No	STS-1/STS-3c	MM	No	OC-3/OC-12	
21G	155.52	55	No	STS-1/STS-3c	SM/MM	Note 6	OC-3/OC-12	1, 4, 6
21G-U	155.52	55	No	STS-1/STS-3c	SM/MM	Note 6	OC-3/OC-12	4, 6
21G2-U	155.52	55	No	STS-1/STS-3c	SM/MM	No	OC-3/OC-12	
21G3-U	155.52	55	No	STS-1/STS-3c	SM/MM	No	OC-3/OC-12	
22D-U	155.52	< 3	Yes	STS-1/VT1.5	MM	No	OC-3	
22F	155.52	33	No	STS-1/VT1.5	SM/MM	No	OC-3	1, 4
22F-U	155.52	33	No	STS-1/VT1.5	SM/MM	No	OC-3	4
22F2-U	155.52	33	Yes	STS-1/VT1.5	SM/MM	No	OC-3	4
22G-U	155.52	51	Yes	STS-1/VT1.5	SM/MM	7.0 dB	OC-3	4
22G2-U	155.52	51	Yes	STS-1/VT1.5	SM/MM	No	OC-3	4
22G3-U	155.52	55	Yes	STS-1/VT1.5	SM/MM	No	OC-3	
22G4-U	155.52	55	Yes	STS-1/VT1.5	SM/MM	No	OC-3	
24G-U	622.08	51	Yes	STS-1/STS-3c/VT1.5	SM	10.0 dB	OC-3	
24H-U	622.08	96	Yes	STS-1/STS-3c/VT1.5	SM	10.0 dB	OC-3	2
26G2-U	51.84	44	Yes	STS-1/VT1.5	SM/MM	13.8 dB	OC-1/OC-3	
27G-U	51.84	44	Yes	STS-1/VT1.5	SM/MM	13.8 dB	OC-3	3, 4
27G2-U	51.84	44	Yes	STS-1/VT1.5	SM/MM	13.8 dB	OC-3	3, 5
23G	622.08	51	No	STS-1/STS-3c	SM	10.0 dB	OC-12	1, 4
23G-U	622.08	51	No	STS-1/STS-3c	SM	10.0 dB	OC-12	
23H	622.08	100	No	STS-1/STS-3c	SM	10.0 dB	OC-12	1, 2, 4
23H-U	622.08	100	No	STS-1/STS-3c	SM	10.0 dB	OC-12	2
23R-U	622.08	51	No		SM	10.0 dB	OC-12 Regen	7
29G-U	622.08	51	Yes	STS-1/STS-3c/VT1.5	SM	10.0 dB	OC-3	
29H-U	622.08	96	Yes	STS-1/STS-3c/VT1.5	SM	10.0 dB	OC-3	2

See notes on following page

Notes:

1. OLIU has *ST®* connectors on faceplate.
2. OLIU operates at 1550 nm. It is for controlled environment use only.
3. OLIU has two sets of optical interfaces.
4. OLIU is discontinued. Functionally equivalent alternatives are available or planned: See the next line in the table. See chapter 7 for availability.
5. OLIU has extended TSI capabilities to support pass-through and hairpin cross-connections for OC-1 rings terminated in function units of a DDM-2000 OC-3.
6. When performing an OC-3 loopback on the 21G/21G-U OLIU, the transmit power switch must be in the low-power position.
7. Discontinued availability (DA) with no replacement.

All OLIUs have universal optical connectors (compatible with *ST*, SC, and FC connectors) except as specified otherwise in notes.

All OLIUs operate at 1310 nm (nominal) except 23H/23H-U, 24H-U, and 29H-U which operate at 1550 nm.

All OLIUs have one optical transmitter and one optical receiver except as specified otherwise in notes.

The “Span Length” column shows maximum span length for single mode fiber in controlled environment, based on certain assumptions about loss budget. (See “Technical Specifications” section for details.)

The “VT/STS Sig. Degrade PS” column indicates which OLIUs support VT1.5 path protection switching based on signal degrade conditions on individual VT1.5 channels. These OLIUs also support path protection switching based on STS signal degrade and VT unequipped conditions.

The “TSI” column indicates what type of cross-connection (time slot interchange) capability is supported by each OLIU.

The “Fiber Type” column indicates whether the OLIU is compatible with single-mode fiber, multimode fiber, or both.

The “Ext. Atten.” column indicates whether an external attenuator is required for optical loopbacks and short span lengths. “No” indicates none required. A dB value indicates the minimum attenuation required.

The “System” column indicates whether the OLIU can be used in the DDM-2000 OC-3 system the DDM-2000 OC-12 system, or both.

Universal Optical Connectors

All the DDM-2000 OC-3 and OC-12 OLIUs have a universal optical connector. This connector, Figure 4-22, is a two-part connector consisting of a faceplate-mounted block and an optical buildout. The faceplate block optionally supports an *ST*, SC, or FC-PC type optical buildout. The OLIU ships with a 0 dB SC type connector installed and a 0 dB *ST* shipped loose (optional FC-PC 0 dB or attenuated buildouts can be ordered separately).

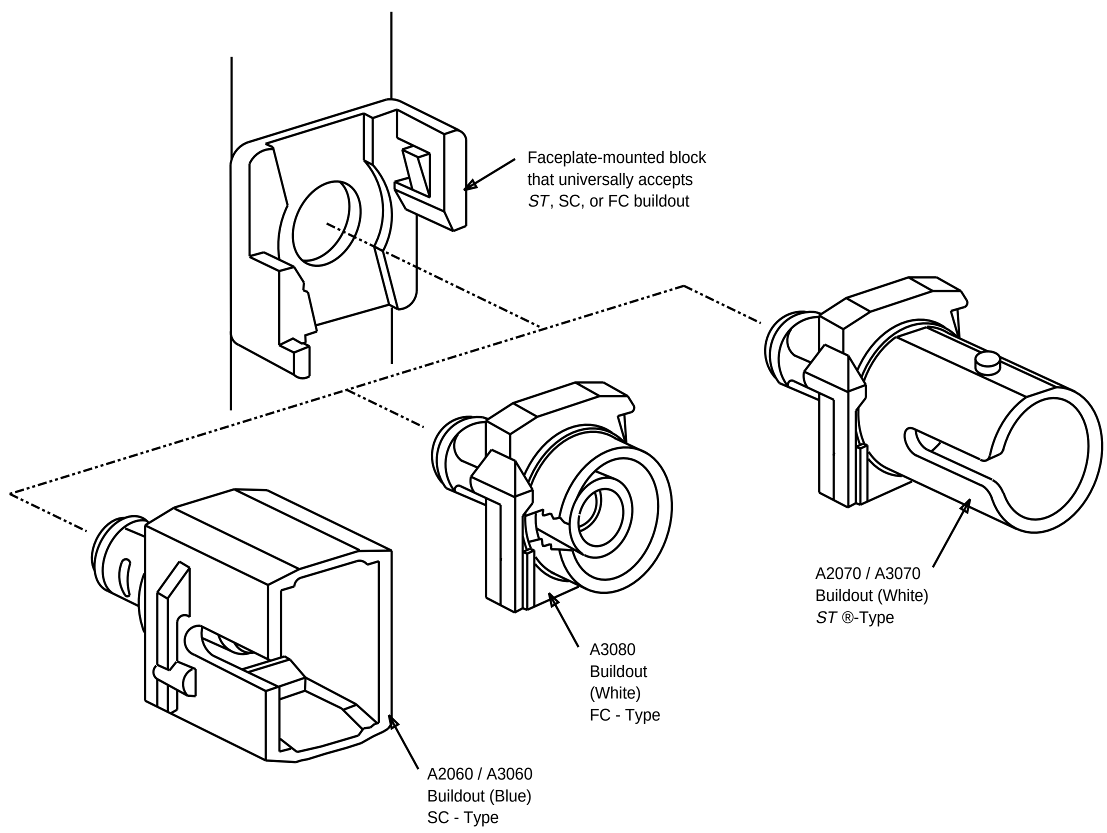


Figure 4-22. Universal Optical Connector

21G/21G-U/21G2-U/21G3-U Optical Line Interface Unit (OLIU)

The 21G/21G-U/21G2-U/21G3-U OLIU circuit packs perform optical/electrical conversion between a 1310 nanometer (nm) OC-3 and an STS-3 signal, multiplexing between STS-3 and three STS-1 signals, and accesses SONET transport overhead. These OLIUs can also operate in an STS-3c mode; in this mode they perform the optical to electrical conversion between an OC-3c and an STS-3c signal and accesses SONET transport overhead. Only 21-type OLIUs can transport an OC-3c.

In the transmit direction, the 21G-type OLIU circuit pack accepts three STS-1 signals from the Function Group circuit packs. The transport overhead bytes (line and section) are inserted and the three STS-1 signals are multiplexed together to one SONET STS-3 signal (155 Mb/s) which is then converted to an optical OC-3 signal for transmission over single-mode or multimode fiber. In the STS-3c mode, the 21G-type OLIU accepts an STS-3c signal, inserts overhead, and converts the resulting signal into an optical OC-3c signal.

In the receive direction, the incoming OC-3 signal is converted back to an electrical STS-3 signal, demultiplexed to three STS-1 signals, and the transport overhead bytes are extracted. The STS-1 signals are pointer processed (interpretation and regeneration) to guarantee frame alignment to the local system clock before they are sent to the Function Group circuit packs. In the STS-3c mode, the 21G-type OLIU converts the incoming OC-3c signal into an electrical STS-3c signal, extracts transport overhead, and performs STS-3c pointer processing.

Fiber access is via a pair of *ST* connectors on the 21G OLIU faceplate, and via a pair of universal optical connectors on the 21G-U/21G2-U/21G3-U OLIU faceplate. (The 21G3-U ships equipped with SC connectors mounted and *ST* connectors shipped loose.) The 21G, 21G-U, 21G2-U, and 21G3-U OLIU photonics comply with SONET long-reach specifications. While single-mode fiber is suggested for optimum performance, multimode facilities are also supported.

The multilongitudinal laser transmitter supplies a non-return-to-zero (NRZ) coded signal. Optical transmit power is automatically adjusted by the laser diode bias current to maintain a constant average optical power output. This mechanism effectively corrects any power variations due to laser aging or environmental conditions and is thresholded to alert technicians before parameter drift affects quality of service.

The 21G-type OLIU's TSI performs cross-connections from the Main shelf position where it has access to the entire capacity of the Main OC-3 signal. The TSI performs cross-connections between the three STS-1 signals in the Main shelf position to the three STS-1 interfaces in the C Function Unit, and two STS-1 interfaces each in the A and B Function Units. The TSI function for each STS-1 channel is provisionable for STS-1 operation. With this functionality, the 21G-type OLIU can be used in add/drop applications (with appropriate software) where only STS-1 "granularity" is needed.

21D/21D-U Optical Line Interface Unit (OLIU)

The 21D/21D-U OLIU circuit pack is a low-cost optical interface. The 21D/21D-U performs the same functions as the 21G-U OLIU but uses low-cost optics to provide an inexpensive solution for interconnecting co-located DDM-2000 OC-3 and OC-12 equipment. The 21D/21D-U OLIU circuit pack performs optical/electrical conversion between the optical interconnect signal level 3 (IS-3) and an STS-3 or an OC-12 multiplexer, or STS-3c signal. The 21D/21D-U OLIU circuit pack also does multiplexing/demultiplexing between three STS-3 and three STS-1 signals, accesses SONET transport overhead, and provides routing of the STS-1s to and from other main and Function Unit slots in the shelf. On an OC-12 multiplexer, the 21D/21D-U OLIU also has an STS-3c mode in which it converts between OC-3c and STS-3c signals, processes transport overhead, and does pointer processing the same as the 21G-U OLIU.

Fiber access is via a pair of *ST* lightguide connectors on the 21D OLIU faceplate, and via universal optical connectors on the 21D-U OLIU faceplates. The 21D/21D-U OLIU operates with only multimode fiber.

22F/22F-U/22F2-U Optical Line Interface Unit (OLIU)

The 22F/22F-U/22F2-U OLIU circuit packs interface with a 1310 nm OC-3 optical line in the transmit and receive directions and supports DDM-2000 add/drop and self-healing ring configurations through its VT1.5/STS-1 TSI capabilities. The 22F/22F-U/22F2-U OLIU circuit packs photonics exceed the SONET intermediate reach requirements.

Fiber access is via a pair of *ST* lightguide connectors on the 22F OLIU faceplate, and via universal optical connectors on the 22F-U and 22F2-U OLIU faceplates. While single-mode fiber is suggested for optimum performance, multimode facilities are also supported.

The multilongitudinal laser transmitter supplies an NRZ-coded signal. Optical transmit power is automatically adjusted by the laser diode bias current to maintain a constant average optical power output. This mechanism effectively corrects any power variations due to laser aging or environmental conditions.

This OLIU's TSI performs cross-connections from the Main shelf position where it has access to the entire Main OC-3 signal. The TSI performs cross-connections between the three STS-1 signals in the Main shelf position to the three STS-1 interfaces in the C Function Unit, and two STS-1 interfaces each in the A and B Function Units. The TSI function for each STS-1 channel is provisionable for VT1.5 or STS-1 operation. When VT1.5 cross-connections are performed, STS-1 path overhead is inserted and accessed. In addition to these cross-connect functions, the TSI provides VT1.5 and STS-1 path selection (protection switching) between Main slots 1 and 2 for self-healing ring applications. On the 22F2-U OLIU, path selection is based on both hard failures and VT1.5 and STS-1 signal degrade BER . The 22F2-U also detects the VT unequipped for path protection.

In the transmit direction, STS-1 signals from the backplane first encounter the TSI function.

- When in the Main position, the TSI is controlled by user provisioning. It connects time slots from the A and B Function Units toward the Main fiber, or back out to the C Function Unit (connection between A and B time slots is not supported). Incoming time slots from Function Unit C may be connected back out to A or B (dropped traffic), or may be connected to time slots for the Main OC-3 transmitter.
- When in the A, B, or C Function Unit positions, the TSI passes through all incoming time slots toward the fiber (no rearrangement).

The three STS-1 outputs of the TSI pass through a pointer alignment stage and then transport overhead is inserted. Finally, these three STS-1 signals are multiplexed into an STS-3 signal (155 Mb/s), which is converted to the transmitted OC-3 signal.

In the receive direction, the incoming OC-3 signal is converted to an electrical STS-3 signal and demultiplexed to three STS-1 signals, and the transport overhead bytes are extracted. After pointers are realigned to the local system clock, TSI is performed as follows:

- When in the Main position, the TSI cross-connects time slots from the fiber to Function Unit time slots.
- When in the A, B, or C positions, the TSI passes time slots from the fiber to the Main position, where they are cross-connected according to the cross-connect provisioning of the 22-type OLIU in the Main slot.

When a 22-type OLIU circuit pack is used in a shelf, all other OLIUs in that shelf must also be 22- or 27-type OLIUs.

22G-U/22G2-U Optical Line Interface Unit (OLIU)

The 22G-U OLIU circuit pack interfaces with a 1310 nm OC-3 optical line in the transmit and receive directions and supports DDM-2000 add/drop and ring configurations through its VT1.5 and STS-1 TSI capabilities. The 22G-U OLIU circuit pack photonics support long reach applications.

The multilongitudinal laser transmitter supplies an NRZ-coded signal. Optical transmit power is automatically adjusted by the laser diode bias current to maintain a constant average optical power output. This mechanism corrects any power variations due to laser aging or environmental conditions.

Fiber access is via a pair of *ST*, SC, or FC-PC lightguide connectors on the 22G-U OLIU faceplate. While single-mode fiber is suggested for optimum performance, multimode facilities are also supported.

The 22G-U and 22G2-U OLIUs are functionally identical to the 22F2-U described above except for the optical interface specifications. See Table 4-3.

22G3-U/22G4-U Optical Line Interface Unit (OLIU)

The 22G4-U OLIU will replace the 22F-type and the 22G-U/22G2-U/22G3-U OLIUs. The 22G4-U OLIU circuit pack interfaces with a 1310 nm OC-3 optical line in the transmit and receive directions and supports DDM-2000 add/drop and ring configurations through its VT1.5 and STS-1 TSI capabilities. The 22G4-U OLIU circuit pack photonics fully comply with SONET long reach applications.

The single longitudinal mode (SLM) laser transmitter supplies an NRZ-coded signal. Optical transmit power is automatically adjusted by the laser diode bias current to maintain a constant average optical power output. This mechanism corrects any power variations due to laser aging or environmental conditions.

Fiber access is via a pair of *ST*, SC, or FC-PC lightguide connectors on the 22G4-U OLIU faceplate. While single-mode fiber is suggested for optimum performance, multimode facilities are also supported.

22D-U Optical Line Interface Unit (OLIU)

The 22D-U OLIU circuit pack interfaces with an IS-3 optical line in the transmit and receive directions, and supports DDM-2000 add/drop and ring configurations through its VT1.5 and STS-1 TSI capabilities.

Fiber access is via a pair of *ST*, SC, or FC lightguide connectors on the 22D-U OLIU faceplate. The 22D-U OLIU can only be used with multimode fiber.

Except for the optical interface specifications, the 22D-U is functionally identical to the 22F2-U and 22G-U OLIUs described above (see Table 4-3).

24G-U Optical Line Interface Unit (OLIU)

The 24G-U OLIU circuit pack used in the OC-3 shelf interfaces with a 1310 nm OC-12 optical line in the transmit and receive directions. The functionality of the 24G-U is similar to the 22-type OLIU circuit packs, with add/drop and ring configurations with its VT1.5 and STS-1 TSI capabilities, but supports OC-12 long reach applications.

The distributed feedback laser supplies a NRZ-coded signal. Optical transmit power is automatically adjusted by the laser diode bias current to maintain a constant average optical power output. This mechanism corrects any power variations due to laser aging or environmental conditions.

Fiber access is via a pair of *ST*, SC, or FC-PC lightguide connectors on the 24G-U OLIU faceplate. Single-mode fiber only is supported due to the increased data rates.

The 24G-U OLIU's TSI performs cross-connections from the Main shelf position and it has access to the entire capacity of the OC-12 signal. Up to three of the 12 STS-1s in the OC-12 payload are presented to the TSI, but all 12 STS-1s are passed through a faceplate connector to the other main 24G-U for ring functionality.

The selected STS-1s from the TSI are cross-connected to the three STS-1 interfaces in the C Function Unit and the two STS-1 interfaces in each of the A and B Function Units. The TSI function for STS-1 channel is provisionable for VT1.5 or STS-1 operation. When VT1.5 cross-connections are performed, STS-1 path overhead is inserted and accessed. In addition to these cross-connect functions, the TSI provides VT1.5 and STS-1 path selection (protection switching) between Main slots 1 and 2 for self-healing ring applications. This path selection is based on hard failures as well as VT1.5/STS-1 signal BER degradation.

In the transmit direction, STS-1 signals from the backplane first encounter the TSI function. In the Main position, the TSI is controlled by user provisioning. It connects time slots from the A and B Function Units toward the Main fiber, or back out to the C Function Unit (connection between A and B time slots is not supported). Incoming time slots from Function Unit C may be connected back out to A or B (dropped traffic) or connected to the Main OC-12 transmitter.

The three STS-1 outputs of the TSI are cross-connected with the 12 STS-1s from the companion 24G-U passed in from the faceplate connector. The pointers are aligned and transport overhead is inserted. Finally, these 12 STS-1 signals are multiplexed to an STS-12 signal (622 Mb/s), which is converted to the transmitted OC-12 optical signal.

In the receive direction, the incoming OC-12 optical signal is converted to an electrical STS-12 signal and demultiplexed to 12 STS-1 signals, and the transport overhead bytes are extracted. After pointers are realigned to the local system clock, three of the 12 STS-1s are selected for input to the TSI and all 12 STS-1s are passed through the faceplate connector to the companion 24G-U in the other main slot. The TSI cross-connects time slots from the fiber to Function Unit time slots.

24H-U Optical Line Interface Unit (OLIU)

The 24H-U OLIU circuit pack used in the OC-3 shelf interfaces with a 1550 nm OC-12 optical line in the transmit and receive directions. The functionality of the 24H-U is identical to the 24G-U OLIU circuit packs, and supports OC-12 long reach applications.

The distributed feedback laser supplies a NRZ-coded signal. Optical transmit power is automatically adjusted by the laser diode bias current to maintain a constant average optical power output. This mechanism corrects any power variations due to laser aging or environmental conditions.

Fiber access is via a pair of *ST*, SC, or FC-PC lightguide connectors on the 24H-U OLIU faceplate. Single-mode fiber only is required to achieve the maximum reach.

The 24H-U OLIU's TSI performs cross-connections from the Main shelf position and it has access to the entire capacity of the OC-12 signal. Up to three of the 12 STS-1s in the OC-12 payload are presented to the TSI, but all 12 STS-1s are

passed through a faceplate connector to the other main 24H-U for ring functionality.

The selected STS-1s from the TSI are cross-connected to the three STS-1 interfaces in the C Function Unit and the two STS-1 interfaces in each of the A and B Function Units. The TSI function for STS-1 channel is provisionable for VT1.5 or STS-1 operation. When VT1.5 cross-connections are performed, STS-1 path overhead is inserted and accessed. In addition to these cross-connect functions, the TSI provides VT1.5 and STS-1 path selection (protection switching) between Main slots 1 and 2 for self-healing ring applications. This path selection is based on hard failures as well as VT1.5/STS-1 signal BER degradation.

In the transmit direction, STS-1 signals from the backplane first encounter the TSI function. In the Main position, the TSI is controlled by user provisioning. It connects time slots from the A and B Function Units toward the Main fiber, or back out to the C Function Unit (connection between A and B time slots is not supported). Incoming time slots from Function Unit C may be connected back out to A or B (dropped traffic) or connected to the Main OC-12 transmitter.

The three STS-1 outputs of the TSI are cross-connected with the 12 STS-1s from the companion 24H-U passed in from the faceplate connector. The pointers are aligned and transport overhead is inserted. Finally, these 12 STS-1 signals are multiplexed to an STS-12 signal (622 Mb/s), which is converted to the transmitted OC-12 optical signal.

In the receive direction, the incoming OC-12 optical signal is converted to an electrical STS-12 signal and demultiplexed to 12 STS-1 signals, and the transport overhead bytes are extracted. After pointers are realigned to the local system clock, three of the 12 STS-1s are selected for input to the TSI and all 12 STS-1s are passed through the faceplate connector to the companion 24H-U in the other main slot. The TSI cross-connects time slots from the fiber to Function Unit time slots.

26G2-U Optical Line Interface Unit (OLIU)

The 26G2-U OLIU circuit pack interfaces with a 1310 nm OC-1 optical line in the transmit and receive directions and supports DDM-2000 OC-3 self-healing ring configurations through its VT1-5/STS-1 time slot interchange (TSI) capabilities. The 26G2-U OLIU circuit pack photonics exceed the SONET span lengths specified for the intermediate reach requirements. Fiber access is via a pair of universal optical connectors on the 26G2-U OLIU faceplate that supports *ST*®, SC-, and FC-type optical connectors. While a single mode fiber is suggested for optimum performance, multimode facilities are also supported.

The 26G2-U OLIU is installed in the Function Unit slots of the DDM-2000 OC-3 Multiplexer. It provides an interface between an OC-1 optical line and electrical VT-G signals. In the transmit direction, it multiplexes up to seven VT-G signals from the low speed or function slots into an STS-1 signal. VT1.5 signals can be cross-connected and switched as needed. The SONET path overhead, as well as

transport overhead bytes, are added on this circuit pack. The STS-1 signal is then scrambled and converted to an OC-1 optical signal.

In the receive direction, the 26G2-U OLIU terminates an OC-1 signal, converts it into an electrical signal, recovers timing, unscrambles the signal, synchronizes with the incoming SONET STS-1 frame, and processes the overhead. Then the signal goes through STS-1 pointer interpretation and the path overhead is removed and processed. The VT-G signals are removed from the STS-1 payload and transmitted via backplane to the low speed or function slots.

27G-U/27G2-U Optical Line Interface Unit (OLIU)

The 27G-U and 27G2-U OLIU circuit packs interface between two 1310 nm OC-1 optical lines in the transmit and receive directions. They can be used in the Main and/or Function Unit slots of the DDM-2000 OC-3 Multiplexer. Each pair of 27-type OLIUs supports up to two independent OC-1 ring interfaces on a DDM-2000 OC-3 Multiplexer (Figure 4-23). To support dual homing applications, one 27-type OLIU of a pair can be installed in one DDM-2000 OC-3 shelf and the other can be installed in another DDM-2000 OC-3 shelf on the same ring.

Fiber access is via four universal optical connectors on the faceplate: one transmit and one receive for each of the two OC-1 ring interfaces. These connectors support *ST*, SC, and FC type optical connectors. Single mode fiber is suggested for optimum performance; multimode facilities are also supported. The OLIU photonics exceed the span length requirements for SONET intermediate reach interfaces. The OLIU optical interfaces are compatible with those of the 26-type OLIU, which is used in the DDM-2000 FiberReach Wideband Shelf.

When used in the Main shelf position, the OLIUs can pass through signals on the OC-1 rings, route signals between the OC-1 ring interfaces and interfaces in the Function Unit slots, and route signals between Function Unit slots. When used in the Function Unit shelf positions, the OLIUs can route signals from the OC-1 ring interfaces to the Main slots.

When used in the Function Unit shelf positions and with the appropriate software release, the 27G2-U OLIU supports additional signal routing capabilities not available with the 27G-U OLIU (see Figure 4-23). With DDM-2000 OC-3 Release 9.1 and later, the 27G2-U OLIU supports “pass-through” routing of VT1.5s on an OC-1 ring in a function unit and routing of VT1.5s from an OC-1 ring in a function unit to another OC-1 ring in the same or another function unit. (Routing between Fn-A and Fn-B is not supported.) With DDM-2000 OC-3 Release 11.0, the 27G2-U OLIU also supports “hairpin local drop” routing of VT1.5s on an OC-1 ring in a function unit to MXRVO/DS1 ports in a different function unit. These are the only differences between the 27G-U and the 27G2-U OLIUs.

When 27-type OLIUs are used in the main shelf position, VT1.5 or STS-1 transmit signals can be routed from the backplane to either of the two OC-1 ring interfaces.

The signal is transmitted on both rotations of the ring. Standard SONET overhead is added on each OC-1 interface transmitted by the OLIU. In the receive direction, the OLIU processes the SONET overhead, monitors the received signals (for parity errors, LOS, line and path AIS, etc.), performs standard STS-1 or VT1.5 path switching as required, and routes the signals to the backplane. In both directions of transmission, the two OC-1 ring interfaces are handled independently.

If the 27-type OLIU is used in a Group 1 or Group 3 shelf, a BBF5 Jumper circuit pack may be required. Refer to the BBF5 description.

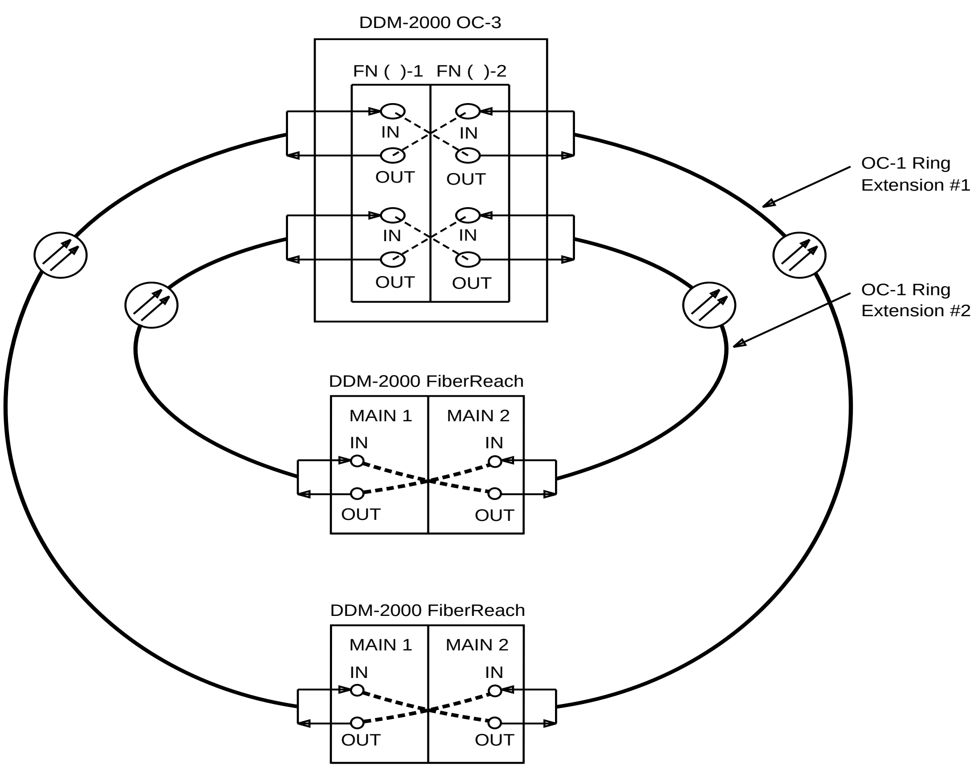


Figure 4-23. 27G2-U Dual OC-1 OLIU in OC-3 Function Unit

29G-U Optical Line Interface Unit (OLIU)

The 29G-U OLIU circuit pack used in the OC-3 shelf interfaces with a 1310 nm OC-12 optical line in the transmit and receive directions.

The distributed feedback laser supplies a NRZ-coded signal. Optical transmit power is automatically adjusted by the laser diode bias current to maintain a constant average optical power output. This mechanism corrects any power variations due to laser aging or environmental conditions.

Fiber access is via a pair of SC, *ST*, or FC-PC lightguide connectors on the 29G-U OLIU faceplate. Single-mode fiber only is required to achieve the maximum reach.

The 29G-U OLIU's TSI performs VT1.5, STS-1, and STS-3c cross-connections from the Main shelf position and it has access to the entire VT1.5 capacity of the OC-12 signal. All 12 STS-1s and 336 VT1.5s in the OC-12 payload are presented to the TSI. A faceplate connector allows passage of pass through signals between Main OLIUs for ring functionality.

The selected STS-1s and VT1.5s from the TSI are cross-connected to the STS-1 interfaces in Function Units A (two STS-1s), B (two STS-1s), or C (three STS-1s). The TSI function for STS-1 channel is provisionable for VT1.5 or STS-1 operation. When VT1.5 cross-connections are performed, STS-1 path overhead is inserted and accessed. In addition to these cross-connect functions, the 29G-U OLIU provides VT1.5 and STS-1 path selection (protection switching) between Main slots 1 and 2 for self-healing ring applications. This path selection is based on hard failures as well as VT1.5/STS-1 signal BER degradation.

In the transmit direction, STS-1 signals from the backplane first encounter the TSI function. In the Main position, the TSI is controlled by user provisioning. It connects time slots from the A (two STS-1s) and B (two STS-1s) Function Units toward the Main fiber, or back out to the C (three STS-1s) Function Unit (connection between A and B time slots is not supported). Incoming time slots from Function Unit C may be connected back out to A or B (dropped traffic) or connected to the Main OC-12 transmitter.

The seven STS-1 inputs from the Function Units slots may be cross-connected with the 12 STS-1s from the companion 29G-U OLIU passed in from the faceplate connector. The pointers are aligned and transport overhead is inserted. Finally, these 12 STS-1 signals are multiplexed to an STS-12 signal (622 Mb/s), which is converted to the transmitted OC-12 optical signal.

In the receive direction, the incoming OC-12 optical signal is converted to an electrical STS-12 signal and demultiplexed to 12 STS-1 signals, and the transport overhead bytes are extracted. After pointers are realigned to the local system clock, all 12 STS-1s are selected for input to the TSI and all 12 STS-1s are passed through the faceplate connector to the companion 29G-U OLIU in the other main slot. The TSI cross-connects STS-1 or VT1.5 time slots from the fiber to Function Unit time slots.

The 29G-U OLIU can also pass through its Main interfaces up to four STS-3c signals and add/drop a single STS-3c from any STS-3c time slot in the Main to Function Unit C.

29H-U Optical Line Interface Unit (OLIU)

The 29H-U OLIU circuit pack used in the OC-3 shelf interfaces with a 1550 nm OC-12 optical line in the transmit and receive directions.

The distributed feedback laser supplies a NRZ-coded signal. Optical transmit power is automatically adjusted by the laser diode bias current to maintain a constant average optical power output. This mechanism corrects any power variations due to laser aging or environmental conditions.

Fiber access is via a pair of SC, *ST*, or FC-PC lightguide connectors on the 29H-U OLIU faceplate. Single-mode fiber only is required to achieve the maximum reach.

The 29H-U OLIU’s TSI performs VT1.5, STS-1, and STS-3c cross-connections from the Main shelf position and it has access to the entire VT1.5 capacity of the OC-12 signal. All 12 STS-1s and 336 VT1.5s in the OC-12 payload are presented to the TSI. A faceplate connector allows passage of pass through signals between Main OLIUs for ring functionality.

The selected STS-1s and VT1.5s from the TSI are cross-connected to the STS-1 interfaces in Function Units A (two STS-1s), B (two STS-1s), or C (three STS-1s). The TSI function for STS-1 channel is provisionable for VT1.5 or STS-1 operation. When VT1.5 cross-connections are performed, STS-1 path overhead is inserted and accessed. In addition to these cross-connect functions, the 29H-U OLIU provides VT1.5 and STS-1 path selection (protection switching) between Main slots 1 and 2 for self-healing ring applications. This path selection is based on hard failures as well as VT1.5/STS-1 signal BER degradation.

In the transmit direction, STS-1 signals from the backplane first encounter the TSI function. In the Main position, the TSI is controlled by user provisioning. It connects time slots from the A (two STS-1s) and B (two STS-1s) Function Units toward the Main fiber, or back out to the C (three STS-1s) Function Unit (connection between A and B time slots is not supported). Incoming time slots from Function Unit C may be connected back out to A or B (dropped traffic) or connected to the Main OC-12 transmitter.

The seven STS-1 inputs from the Function Units slots may be cross-connected with the 12 STS-1s from the companion 29H-U OLIU passed in from the faceplate connector. The pointers are aligned and transport overhead is inserted. Finally, these 12 STS-1 signals are multiplexed to an STS-12 signal (622 Mb/s), which is converted to the transmitted OC-12 optical signal.

In the receive direction, the incoming OC-12 optical signal is converted to an electrical STS-12 signal and demultiplexed to 12 STS-1 signals, and the transport overhead bytes are extracted. After pointers are realigned to the local system clock, all 12 STS-1s are selected for input to the TSI and all 12 STS-1s are passed through the faceplate connector to the companion 29H-U OLIU in the other main slot. The TSI cross-connects STS-1 or VT1.5 time slots from the fiber to Function Unit time slots.

The 29H-U OLIU can also pass through its Main interfaces up to four STS-3c signals and add/drop a single STS-3c from any STS-3c time slot in the Main to Function Unit C.

BBF5 Jumper Circuit Pack

In DDM-2000 FiberReach host applications using the DDM-2000 OC-3 Multiplexer Group 1 or Group 3 shelves, the BBF5 jumper circuit pack connects signals between slots of a Function Unit equipped with 27-type OLIUs. The BBF5 also cross-couples the STS-1 signals between Function Units equipped with 27G2-U OLIUs. **The BBF5 circuit pack is not needed in Group 4 shelves in any application**. The BBF5 must be installed in Slot 8 of the low-speed group associated with the Function Unit where both Function Unit slots are equipped with 27G-U OLIUs. BBF5 circuit packs must be installed in slots 4 and 8 of the low-speed group associated with the Function Unit where both Function Unit slots are equipped with 27G2-U OLIUs. Depending on the cross-connection configuration, the removal of a BBF5 may affect transmission and/or communications over the DCC interface.

DDM-2000 OC-12 Multiplexer

Interfaces and Multiplexing

Interfaces

The DDM-2000 OC-12 Multiplexer supports DS3, EC-1, OC-3 and IS-3 low-speed interfaces and OC-12 high-speed interfaces at both 1310 and 1550 nm wavelengths. The DS3 interface accepts any DSX-3 compatible signal (clear channel interface), and the OC-3 and OC-12 interfaces are SONET compliant. The IS-3 interface is a low-cost optical interface primarily intended for DDM-2000 OC-3/OC-12 interworking.

Terminal and Hubbing Configuration

The multiplexing operations in the DDM-2000 OC-12 Multiplexer are shown in Figure 4-24 for terminal and hubbing application. Each low-speed signal is converted to an internal STS-1, or STS-3c, for OC3c transport, signal which is then routed to the TSI circuit pack. The TSI circuit pack sends the STS-1 or STS-3c signals to the OC-12 circuit pack. The OC-12 circuit pack multiplexes the individual STS-1 or STS-3c signals to one STS-12 signal. The internal STS-12 signal is then converted to an OC-12 optical signal for transmission over single-mode fiber.

In the receive direction, the incoming OC-12 signal is converted back to an electrical STS-12 and demultiplexed to STS-1 or STS-3c signals. The STS-1 or STS-3c signals are routed to the TSI circuit pack. The TSI circuit pack maps the STS-1 or STS-3c signals to the four Function Units on the shelf. For a DS3 drop, the DS3 signal is recovered from the STS-1 or STS-3c signal. For an EC-1 drop, the EC-1 signal is derived directly from the STS-1 signal. For an OC-3 drop, the OC-3 circuit pack multiplexes three STS-1 or STS-3c signals into an STS-3 signal and converts the signal to an optical carrier. For STS-3c signals, the OC-3 circuit pack converts the signal directly to the optical carrier.

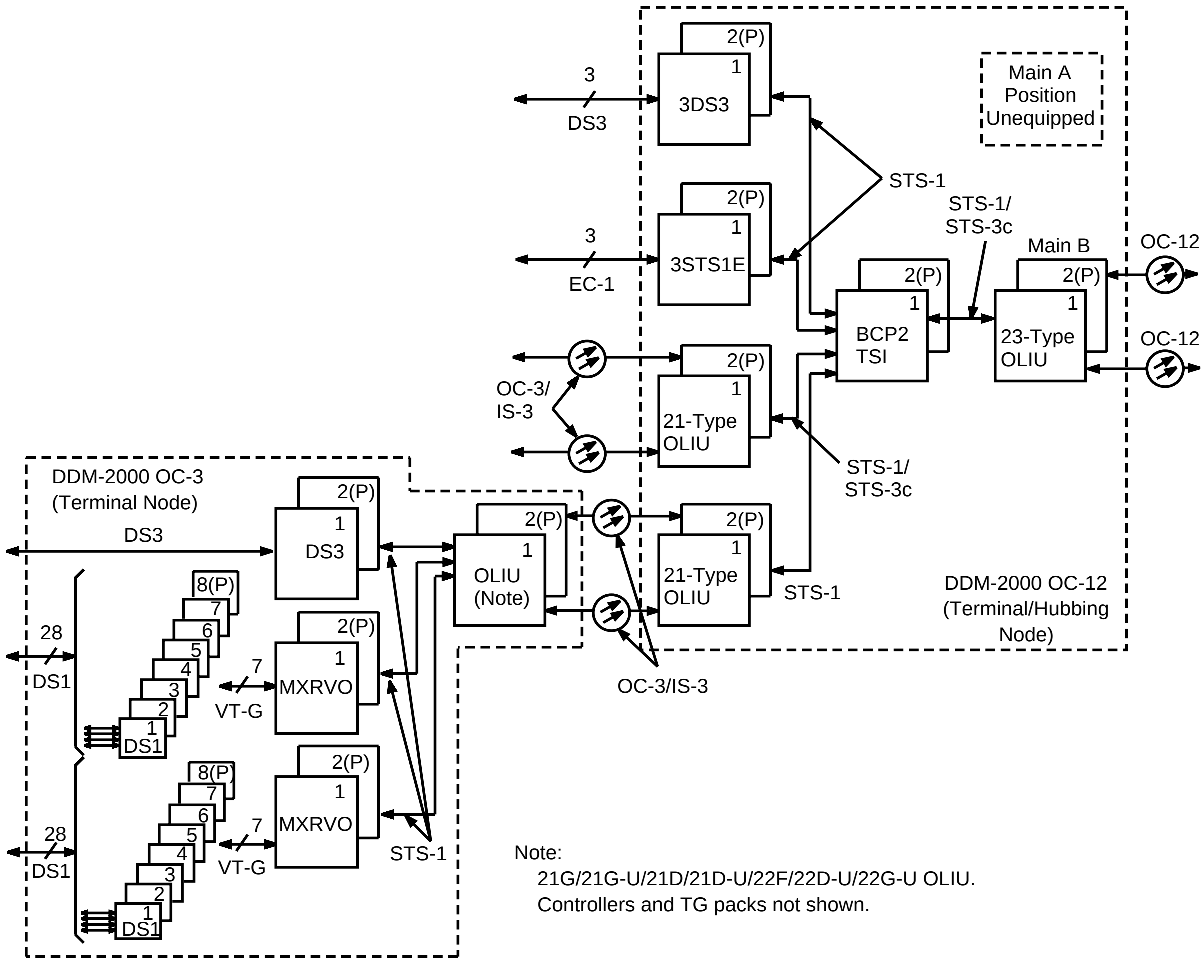


Figure 4-24. DDM-2000 OC-12 Multiplexer Block Diagram — Hubbing and Terminal Node

Path-Switched Ring Configurations

Figure 4-25 is a block diagram of the DDM-2000 OC-12 Multiplexer VT1.5/STS-1 path switched ring shelf configuration. The DDM-2000 OC-12 Multiplexer interfaces to the ring through the Main slots at the OC-12 rate and uses its programmable TSI capability. Path switching can be done on STS-3c paths, STS-1 paths, VT1.5 paths, by interworking with a DDM-2000 OC-3 Multiplexer ring node, or a mixture of these. Twelve DS3s, 12 EC-1s, 4 OC-3/IS-3 1+1 linear optical extensions, 4 OC-3/IS-3 0x1 optical interfaces (for ring interworking with the DDM-2000 OC-3 Multiplexer), or equivalent combination can be added/ dropped from the DDM-2000 OC-12 Multiplexer self-healing ring at any node. Because of the ring's path protection scheme, time slots must be reserved all the way around the ring for all ring traffic, limiting the capacity of the ring to the OC-12 line rate. Like the add/drop topology, the TSI feature offers full flexibility in assigning signals between low-speed DS3, EC-1 or OC-3 ports and the high-speed interface at each shelf.

The DDM-2000 OC-12 Multiplexer STS-1 DRI application uses the same shelf configuration as the DDM-2000 OC-12 Multiplexer path switched ring (Figure 4-25). In this configuration, the DDM-2000 OC-12 Multiplexer can provide STS-1 DRI with another OC-12 ring, an OC-3 ring or an OC-48 ring, with redundant signal appearances at the two central offices via EC-1 interfaces. STS-1 paths are provisioned for drop and continue at the interconnecting nodes and path selection is at the STS-1 level. When used with the DDM-2000 OC-3 Multiplexer, the DDM-2000 OC-12 Multiplexer VT1.5/STS-1 DRI application can be created with the drop and continue feature implemented in the DDM-2000 OC-3 Multiplexer shelf. The DDM-2000 OC-3 and OC-12 Multiplexer path switched ring architecture allows mixing of drop and continue circuits with standard path switched circuits.

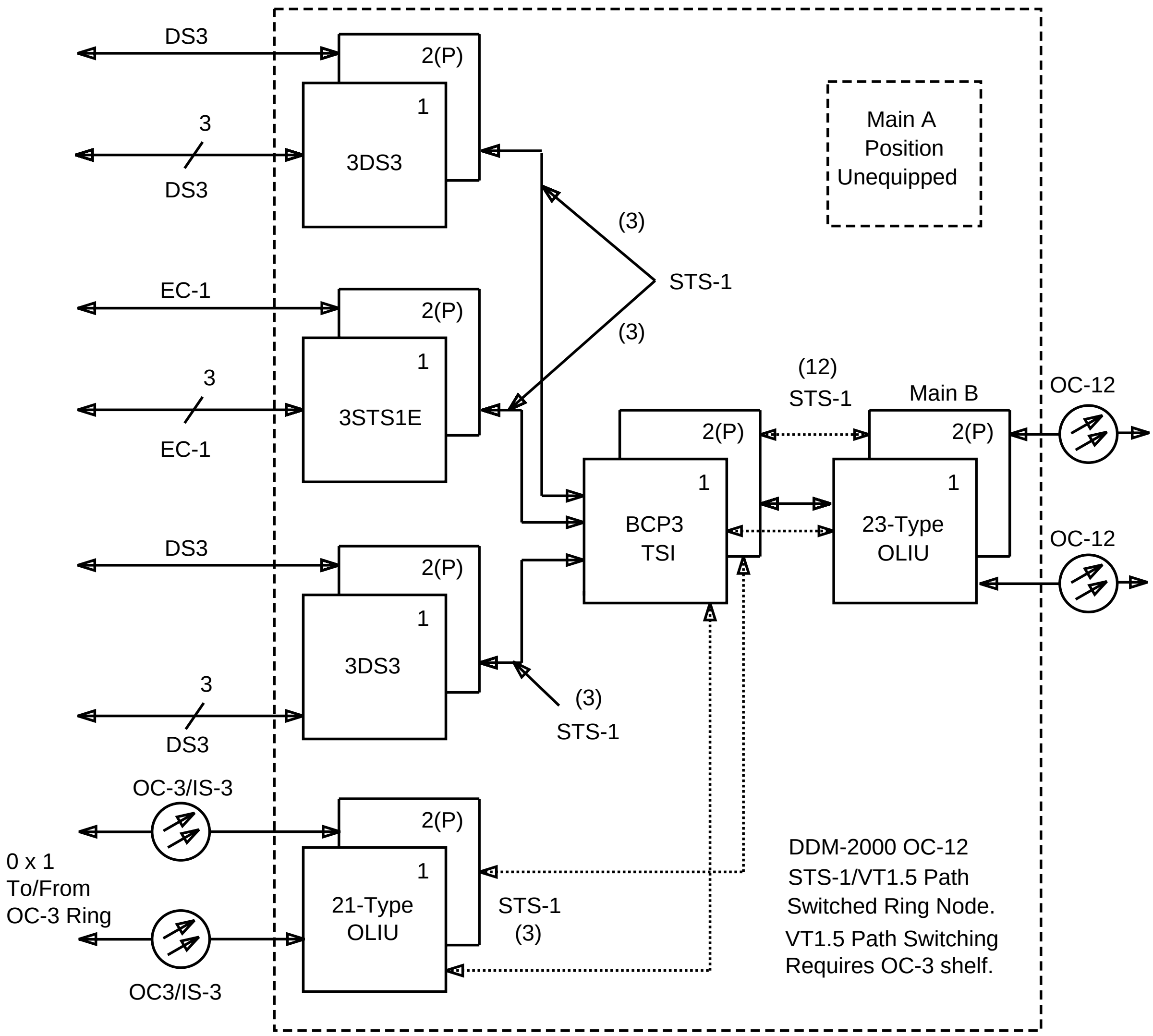


Figure 4-25. OC-12 Multiplexer Block Diagram — VT1.5/STS-1 Path Switched Ring

Ring (0x1) Low-Speed Interfaces

The DDM-2000 OC-12 ring supports (0x1) OC-3/IS-3 interfaces in its Function Unit slots. These interfaces must be provisioned as 0x1 (see Figure 4-26). Signals pass through the DDM-2000 OC-12 transport ring and exit to the DDM-2000 OC-3 ring. OC-12 Function Unit slot FN(x)-1 is connected to OC-3 Main-1 and OC-12 Function Unit slot FN(x)-2 is connected to OC-3 Main-2. Switching is not done on the DDM- 2000 OC-12 Multiplexer on these lines, or paths on these lines; rather VT1.5 or STS-1 level path switching is done on the DDM-2000 OC-3 Multiplexer. This allows DDM-2000 OC-3 nodes running ring software to interface with DDM-2000 nodes of an OC-12 ring in such a way as to provide ring-on- ring architecture. Each OC-3 ring so supported occupies up to three STS-1 time slots on the OC-12 ring. Each OC-12 node can provision the same STS-1 time slots as other OC-12 nodes to drop to the OC-3 shelf (to share STS-1s among several OC-3 shelves) or the OC-12 node can provision different STS-1s at different sites. The OC-12 ring passes the contents of these STS-1 time slots between the low-speed OC-3/IS-3 lines and OC-12 high-speed lines without terminating them or performing any path protection switching on them. Up to four OC-3 rings can be supported in this fashion by an OC-12 ring to maximize the OC-12 bandwidth utilization. This allows access to any and all VT1.5 signals at an OC-12 site.

The OC-3/IS-3 lines between an OC-12 node and an OC-3 node connected in a ring (0x1) fashion behave like the OC-3 lines between the nodes on an OC-3 ring and do not perform line level protection switching. Instead, the OC-3 shelves perform the normal path protection switching functions.

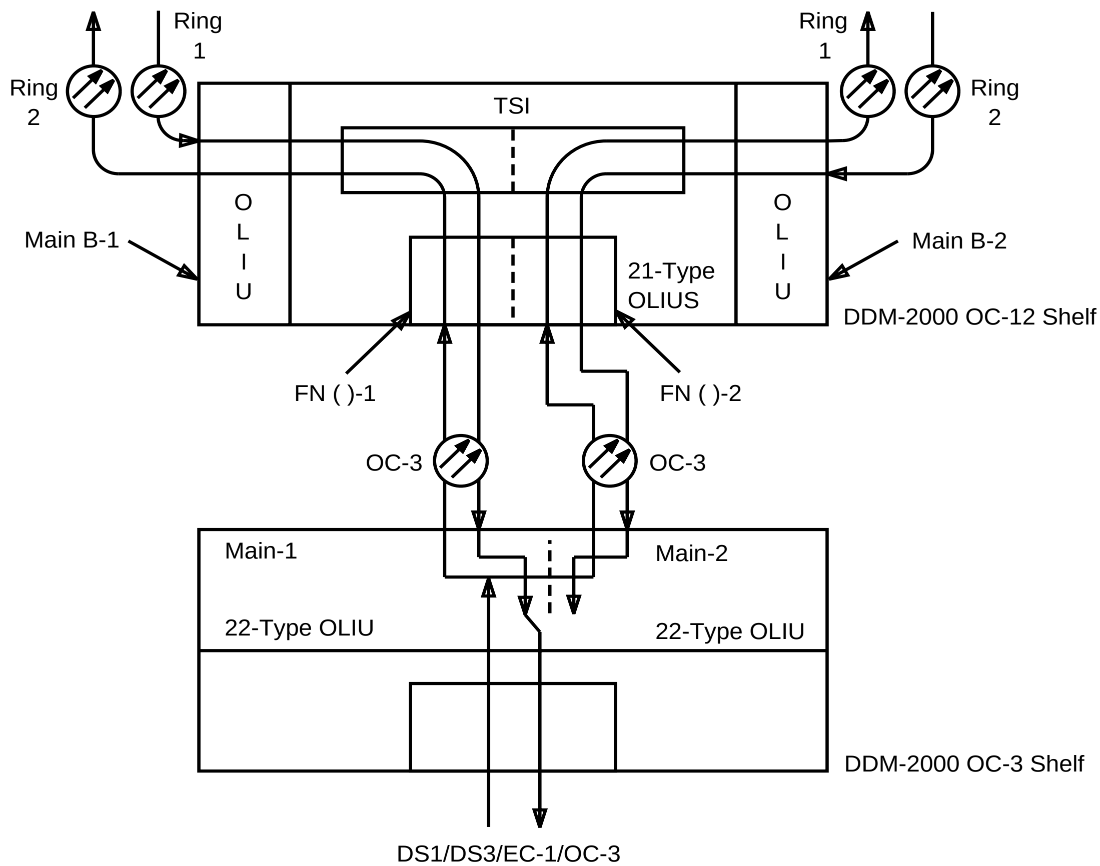


Figure 4-26. Ring (0x1) Low-Speed Interfaces

1+1 Optical Extension Between OC-12 and OC-3

See Figure 4-27 and Figure 4-28. In DDM-2000 OC-12 Release 5.0, the Function Units in the DDM-2000 OC-12 shelf can contain 1+1 protected OC-3 circuit packs. This allows a DDM-2000 OC-12 shelf to connect to the Main slots of a linear DDM-2000 OC-3 shelf. The signals between the DDM-2000 OC-12 and OC-3 shelves can be either OC-3 or OC-3c signals. This allows more options in designing a DDM-2000 network, such as adding a linear add/drop DDM-2000 OC-3 shelf off of a DDM-2000 OC-12 ring. In the transmit direction, a circuit pack failure will cause a switch. In the receive direction, an incoming STS signal failure or circuit pack failure will cause a switch.

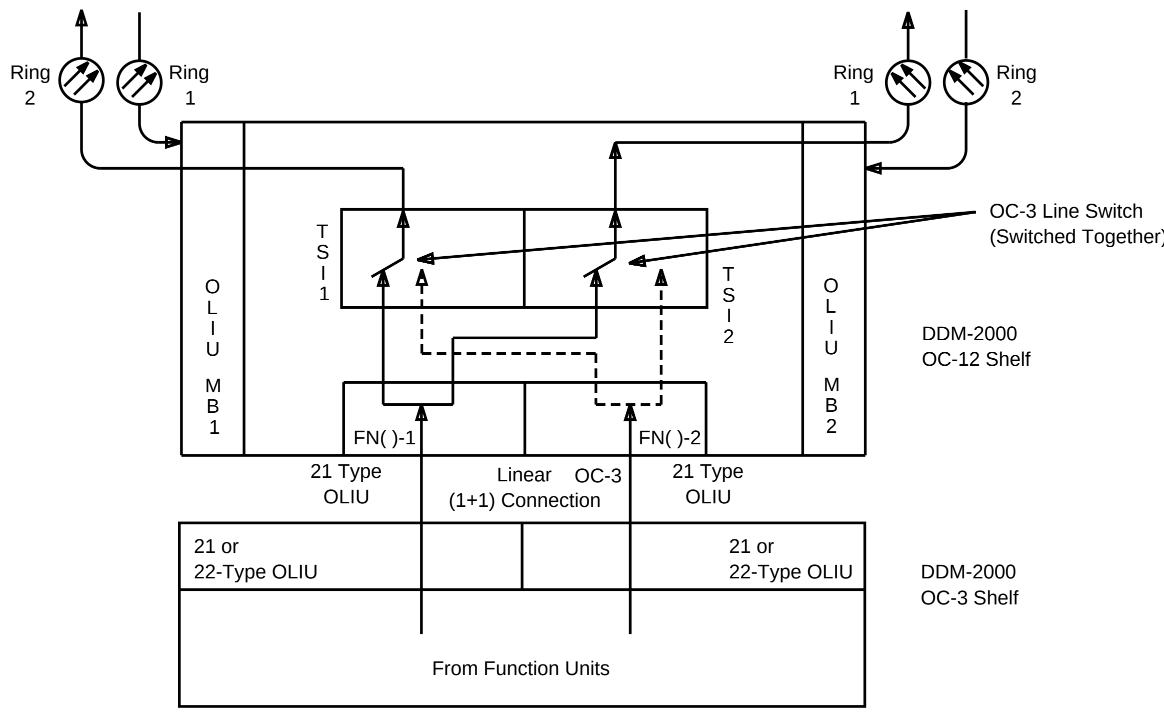


Figure 4-27. OC-12 Ring Shelf with Linear (1+1) OC-3 Low-Speed Interfaces (Transmit)

Note that for OC-12 OLIU or incoming STS-1 path failure, the STS path switch takes place in the TSI. For TSI circuit pack failure, the switch occurs in the Function Unit OLIUs.

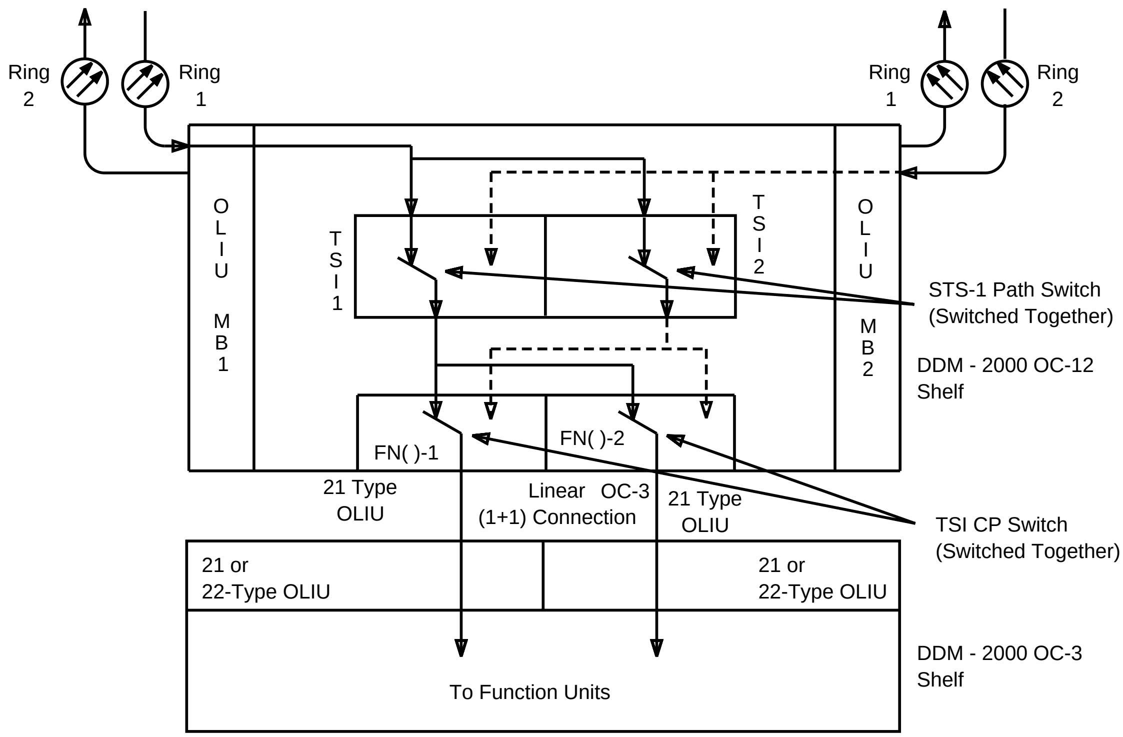


Figure 4-28. OC-12 Ring Shelf with Linear (1+1) OC-3 Low-Speed Interfaces (Receive)

The DDM-2000 OC-12 Regenerator supports an OC-12 high-speed interface (Figure 4-29). The OC-12 interface receives and transmits a standard long reach SONET optical signal. In the receive direction, the attenuated OC-12 optical signal is detected, converted to an internal electrical STS-12 signal, and regenerated by the 23R-U circuit pack. The regenerated STS-12 signal is then converted back to an amplified OC-12 optical signal for retransmission over single-mode fiber.

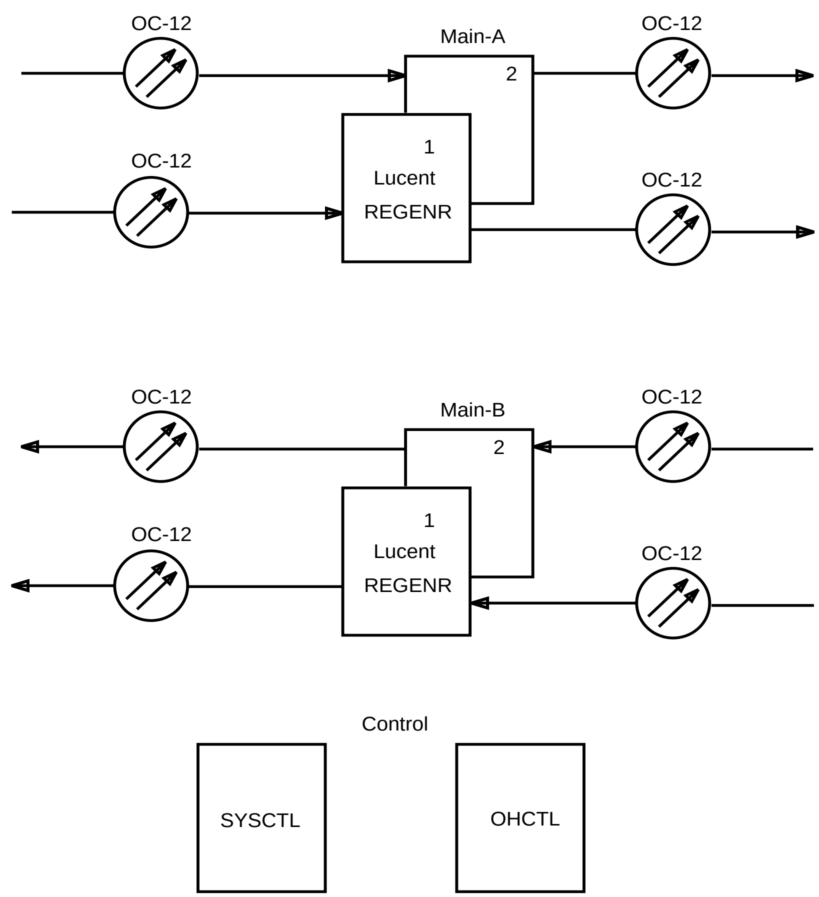


Figure 4-29. DDM-2000 OC-12 Regenerator Block Diagram

Electrical Interface Circuit Packs

BBG11/BBG11B Triple DS3 Low-Speed Interface (3DS3)

The BBG11/BBG11B 3DS3 triple DS3 low-speed interface circuit pack provides a mapping between three DS3 low-speed interfaces and three internal STS-1 signals. Signal specifications and mapping functions for each DS3 are identical to the DS3 circuit pack of the DDM-2000 OC-3 Multiplexer.

The BBG11B 3DS3 circuit pack provides enhanced DS3 performance monitoring capabilities with software releases 3.1 and later. The BBG11B is backward compatible with the BBG11.

BBG12 Triple EC-1 Interface (3STS1E)

The BBG12 3STS1E circuit pack provides low-speed EC-1 interfaces for interworking with other SONET products. Three bidirectional EC-1 signals can be terminated for each protected circuit pack pair.

Each of the three EC-1 ports of the 3STS1E circuit pack receives an EC-1 signal (51.84 Mb/s), removes B3ZS coding, descrambles the signal, and sends the resulting STS-1 signal to the TSI circuit pack for cross-connection to an OC-3 or OC-12 interface. The STS-1 signal can contain embedded VT1.5 signals or a DS3 signal. In the transmit direction, the STS-1 signal is received from the TSI circuit pack, scrambled, B3ZS encoded, and transmitted on the EC-1 interface.

Time Slot Interchange Circuit Packs

BCP2 STS-1 TSI (TSI) - FIXED

The BCP2 STS-1 TSI circuit pack provides the capability to route STS-1s or STS-3cs from the OC-12 line signal to the drop interfaces on the OC-12 Multiplexer shelf. This circuit pack provides a fixed mapping between the STS-1 signals on the line and the physical location on the drop side of the shelf.

BCP3 Flexible STS-1 TSI (TSI) - FLEX

The BCP3 STS-1 TSI circuit pack allows cross-connections between STS-1 and STS-3c signals and the different interfaces on the DDM-2000 OC-12 Multiplexer shelf. Fully flexible TSI capability is provided between the high-speed OC-12 interfaces and any of the low-speed interfaces, allowing any STS-1 or STS-3c time slots on the OC-12 interface to be connected to any of the STS-1 or STS-3c time slots in the Function Units.

On the low-speed side, the BCP3 TSI receives internal STS-1 or STS-3c signals from the Function Unit slots. The signal is cross-connected within the TSI and

redirected to the appropriate time slot in the OC-12 signal or to a time slot in another Function Unit.

Optical Interface Circuit Packs

(See Table 4-3 for a Feature Summary of DDM-2000 OLIUs.)

21D/21D-U and 21G/21G-U/21G2-U/21G3-U Optical Line Interface Unit (OLIU)

The 21D/21D-U and 21G/21G-U/21G2-U/21G3-U OLIU circuit packs provide the IS-3 and OC-3 low-speed interface respectively, for the DDM-2000 OC-12 Multiplexer. These are the same OLIUs used in the DDM-2000 OC-3 Multiplexer.

23G/23G-U Optical Line Interface Unit (OLIU)

The 23G/23G-U OLIU circuit pack interfaces with a 1310 nm OC-12 optical line. The 23G/23G-U OLIU circuit pack photonics are fully compliant with the SONET long-reach requirements. See Section 11, "Technical Specifications," for performance details.

Fiber access is via a pair of *ST* lightguide connectors (23G) or universal optical connector (23G-U) on the OLIU faceplate. The multilongitudinal laser transmitter supplies an NRZ-coded signal. Optical transmit power is monitored to aid maintenance and fault sectionalization. The laser transmitter has a companion device that monitors the backface diode current and adjusts the laser diode bias current to maintain a constant average optical power output. This mechanism effectively corrects any power variations due to laser aging or environmental conditions and is thresholded to alert technicians before parameter drift affects quality of service.

In the transmit direction, the 23G/23G-U OLIU circuit pack accepts 12 STS-1 signals, 4 STS-3cs, or a mixture of equivalent capacity, from the Function Groups via the TSI circuit pack. The SONET transport overhead bytes are inserted, STS-1 signals are multiplexed to STS-3 signals and the STS-3 and STS-3c signals are then multiplexed to one STS-12 signal (622 Mb/s). The electrical STS-12 signal is converted to an optical OC-12 signal for transmission over single-mode fiber.

In the receive direction, the OC-12 signal is converted back to an electrical STS-12 signal, demultiplexed to STS-3 and STS-3c signals, then to STS-1 signals, and the transport overhead is terminated. The STS-1 and STS-3c signals are pointer processed (interpretation and regeneration) to guarantee frame alignment to the local system clock before they are sent to the Function Groups via the TSI circuit pack.

Fiber access is via a pair of *ST* lightguide cable connectors (23G) or universal optical connectors (23G-U) on the OLIU faceplate. For applications requiring external optical attenuators, the faceplate-mounted receive connector is designed

to accept a lightguide buildout. Available buildouts are A3010B - 5 dB, A3010D -10 dB, and A3010F - 15 dB.

23H/23H-U Optical Line Interface Unit (OLIU)

The 23H/23H-U OLIU provides a 1550 nm interface between an OC-12 optical line and 12 STS-1 signals. In the transmit direction, the 23H/23H-U OLIU circuit pack accepts 12 STS-1 signals, 4 STS-3cs, or a mixture of equivalent capacity from the Function Groups via the TSI circuit pack. The SONET transport overhead bytes are inserted, STS-1 signals are multiplexed to STS-3 signals, and the STS-3 and STS-3c signals are then multiplexed to one STS-12 signal (622 Mb/s). The electrical STS-12 signal is converted to an optical OC-12 signal for transmission over single-mode fiber.

In the receive direction, the 23H/23H-U OLIU receives an optical OC-12 signal and converts it to an electrical signal. It frames on and descrambles the signal, processes the transport overhead, and demultiplexes the STS-12 into STS-1 and STS-3c signals. It performs pointer processing and frame alignment on each STS-1 and STS-3c and delivers them to the TSI circuit packs.

The 23H/23H-U OLIU performs maintenance and provisioning functions associated with the STS-1 and OC-12 inputs and outputs. It provides access to the line and section overhead in the STS-12 signal and interfaces to the TSI circuit pack at the STS-1 rate and to the optical line at the OC-12 rate. It interfaces to the BBG5 SYSCTL and BCP1 OHCTL and sends recovered timing signals to the TGS circuit packs. The 23H/23H-U OLIU receives its timing signals from the TSI circuit packs.

Fiber access is via a pair of *ST* lightguide cable connectors (23H) or universal optical connectors (23H-U) on the OLIU faceplate. Single-mode fiber is required for optimum performance. The 23H/23H-U is not hardened for uncontrolled environments and is used in CO applications. See Section 11, "Technical Specifications," for performance details.

For applications requiring external optical attenuators, the faceplate mounted-receive connector is designed to accept a lightguide buildout. Available buildouts are A3010B - 5 dB, A3010D - 10 dB, and A3010F - 15 dB. For loopback testing, use the 4C test cable. See the "OC-12 Ordering — Miscellaneous Equipment and Tools" tab.

23R-U Regenerator (REGENR)

The 23R-U REGENR circuit pack interfaces with an OC-12 optical line in the transmit and receive directions. The 23R-U REGENR circuit pack photonics are the same as the 23G/23G-U OLIU. The photonics are fully compliant with the SONET long-reach requirements. The 23R-U REGENR is classified discontinued availability (DA).

In the receive direction, the 23R-U REGENR circuit pack detects an attenuated OC-12 optical signal. The OC-12 signal is converted to an internal electrical STS-12 signal and regenerated. The regenerated STS-12 signal is then converted back to an amplified OC-12 optical signal for retransmission over single-mode fiber. Fiber access is via a pair of universal optical connectors on the OLIU faceplate. The 23R-U REGENR circuit pack was classified discontinued availability (DA).

Synchronization

Synchronization Functions

Synchronization is an important part of all SONET products. The DDM-2000 OC-3 and OC-12 Multiplexers are designed for high performance and reliable synchronization.

The DDM-2000 OC-3 and OC-12 Multiplexers support three synchronization reference configurations. Typical CO installations should be synchronized with DS1 timing references from a Stratum 3 or better office clock (external timing). When required, a multiplexer can operate without synchronization inputs (free-running) using its internal timing generator. Finally, in small COs or remote sites, a multiplexer derives its synchronization from the incoming OC-1, OC-3, or OC-12 optical signal (line timing). These timing modes are supported by the BBF2B/BBF2C TGS or BBF4 TG3 circuit packs. The three basic timing modes can be combined into various network configurations. See Section 6, "System Planning and Engineering," for more information.

The DDM-2000 OC-12 Regenerator derives its synchronization from the incoming OC-12 optical signal and uses this derived timing to synchronize the outgoing OC-12 signal on the same 23R-U REGENR circuit pack (through timing). Therefore, no TGS circuit packs or external references are required by the OC-12 Regenerator. Since timing is passed through the OC-12 Regenerator transparently, synchronization of DDM-2000 OC-12 terminal multiplexers is unaffected.

Internal timing functions — reference interfaces, the on-board clock elements, and timing distribution — are located in the synchronous timing generator (TGS) or Stratum 3 Timing Generator (TG3) circuit packs. The TGS or TG3 circuit packs distribute clock and frame signals, derived from the selected reference source, to the transmission packs.

In support of evolution toward SONET-based timing distribution, the DDM-2000 OC-3 and OC-12 Multiplexers can derive an optional DS1 timing output from the incoming OC-1, OC-3 or OC-12 high-speed interface. With this capability, the DDM-2000 network can distribute high quality synchronization among its sites. For example, the building integrated timing supply (BITS) clock in each office can be synchronized using SONET facilities by using the DS1 timing output from the DDM-2000 in each office.

An optional multiple (MULT) cable allows a pair of DS1 timing references to be shared among an entire bay of DDM-2000 OC-3 and OC-12 Multiplexer shelves. This minimizes the cost of timing distribution ports on the office clock.

Synchronization Circuit Packs

BBF2B/BBF2C Synchronous Timing Generator (TGS)

The TGS circuit pack (BBF2B/BBF2C) supports three timing modes to serve a wide range of DDM-2000 OC-3/OC-12 synchronization needs: external timing, line timing, and free running. In addition, the BBF2B/BBF2C TGS circuit pack can provide a DS1 timing output for network synchronization when operating in the external or line timed modes.

In external timing mode, each TGS accepts one DS1 reference from an external Stratum 3 or better clock. A high-stability digital phase-locked loop (DPLL) removes any transient impairments on the DS1 reference for improved jitter performance.

In line timing mode, the TGS derives local shelf timing from the received optical signal.

In free-running mode, the TGS derives timing from a high stability temperature-compensated, voltage-controlled crystal oscillator.

When the DS1 timing output is enabled for network synchronization, a DS1 timing output is derived from the received optical signal and provided on the DS1 timing output backplane connector. Otherwise, the DS1 timing output is provisioned for MULT mode which is used for cascading the DS1 input reference coming from an external clock source to adjacent shelves.

In case of unprotected synchronization reference failure, the TGS will switch to "holdover mode" and continue to provide system timing, using the internal oscillator to maintain the last known good reference frequency. If the DS1 timing output is enabled for network synchronization, DS1 AIS will be inserted on detection of unprotected synchronization reference failure.

SONET synchronization messaging is used to communicate the quality of subnetwork timing, internal timing status, and timing states throughout a subnetwork. Transitions to and from holdover, for shelf timing, and to and from DS1 AIS, for the DS1 output, are based on synchronization messages received over the optical line from which the DDM-2000 OC-3/OC-12 system is extracting timing. See Section 6, "System Planning and Engineering," for more information on synchronization messaging.

BBF4 Stratum 3 Timing Generator (TG3)

The TG3 circuit pack (BBF4) supports three timing modes to serve a wide range of DDM-2000 OC-3/OC-12 synchronization needs: external timing, line timing, and free running. In addition, the BBF4 TG3 circuit pack can provide a DS1 timing output for network synchronization when operating in the external or line timed modes.

In external timing mode, each TG3 accepts one DS1 reference from an external Stratum 3 or better clock. A high-stability digital phase-locked loop (DPLL) removes any transient impairments on the DS1 reference for improved jitter performance.

In line timing mode, the TG3 derives local shelf timing from the received optical signal.

In free-running mode, the TG3 derives timing from a high stability temperature-compensated, voltage-controlled crystal oscillator. This oscillator is capable of stratum 3 accuracy.

When the DS1 timing output is enabled for network synchronization, a DS1 timing output is derived from the received optical signal and provided on the DS1 timing output backplane connector. Otherwise, the DS1 timing output is provisioned for MULT mode which is used for distributing the DS1 input reference coming from an external clock source to adjacent shelves.

In case of unprotected synchronization reference failure, the TG3 will switch to "holdover mode" and continue to provide system timing, using the internal oscillator to maintain the last known good reference frequency. If the DS1 timing output is enabled for network synchronization, DS1 AIS will be inserted on detection of unprotected synchronization reference failure.

SONET synchronization messaging is used to communicate the quality of subnetwork timing, internal timing status, and timing states throughout a subnetwork. Transitions to and from holdover, for shelf timing, and to and from DS1 AIS, for the DS1 output, are based on synchronization messages received over the optical line from which the DDM-2000 OC-3/OC-12 system is extracting timing. See Section 6, "System Planning and Engineering," for more information on synchronization messaging.

Control

General

The DDM-2000 OC-3 and OC-12 Multiplexers provide extensive control features, accessible through a number of technician and operations system (OS) interfaces. In addition to accessing local DDM-2000 OC-3 and OC-12 Multiplexers through direct interfaces, technicians and operations systems can use the single-ended operations features provided by the DCC in the OC-3 or OC-12 signal to reach remote shelves. Control functions are provided by the OHCTL and SYSCTL circuit packs.

Reflecting the numerous common modules shared by the DDM-2000 OC-3 and OC-12 Multiplexers and the integrated nature of DDM-2000 Multiplexer applications, the following discussion of control features applies to both systems unless noted otherwise.

The OC-12 Regenerator uses the same control circuit packs as the DDM-2000 OC-12 Multiplexer, but supports only those control features necessary to support the limited functions of the OC-12 Regenerator. Features not applicable to the OC-12 Regenerator are noted in the following paragraphs.

Three-Tiered Operations* Interface

The DDM-2000 Multiplexer maintenance procedures are built on three levels of system information and control. The first tier is provided by the user panel and faceplate LEDs, displays, and pushbuttons. The second tier uses a CIT to provision and retrieve detailed reports of performance monitoring, alarms and statuses, and system configuration for both local and remote systems. The third tier uses the OS interface of the DDM-2000 to monitor performance, gather alarm information, and configure the system.

User Panels

The DDM-2000 OC-3 and OC-12 Multiplexers employ a common user panel design. The user panel provides system-level information and control functions. The condition of the individual circuit packs can be determined using faceplate LEDs. These features enable operations tasks (for example, system installation or circuit pack replacement) to be performed without a CIT or external test equipment.

* The introduction of Target ID Address Resolution Protocol (TARP) for Operations Interworking (OI) in DDM-2000 OC-3 Release 13.0 and 15.0 and OC-12 Release 7.0 will effect the operations of some features in the three tiers. Refer to Section 5, “Operations, Administration, Maintenance, and Provisioning,” for more information.

The user panel is common to all DDM-2000 Multiplexer and OC-12 Regenerator shelves. The DDM-2000 OC-3 and OC-12 Multiplexer user panels for Group 1 or Group 3 OC-3 Shelves and Group 1 OC-12 Shelves are shown in Figure 4-30 and Figure 4-31, respectively.

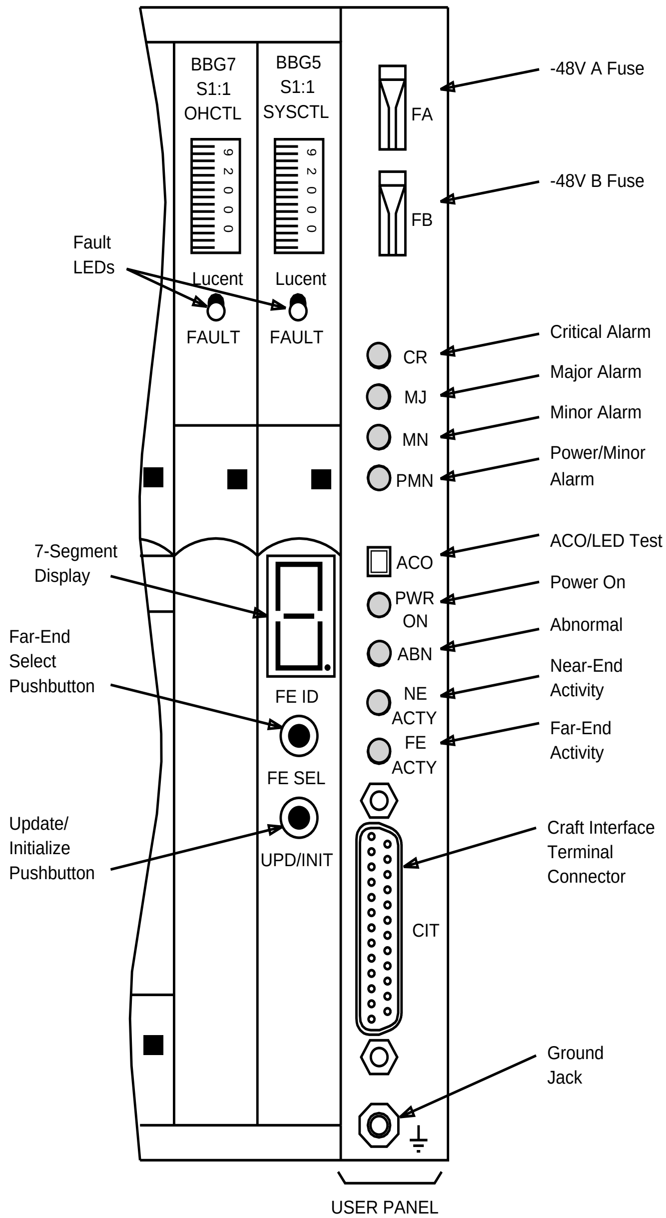


Figure 4-30. DDM-2000 OC-3 User Panel for Group 1 or Group 3 Shelf

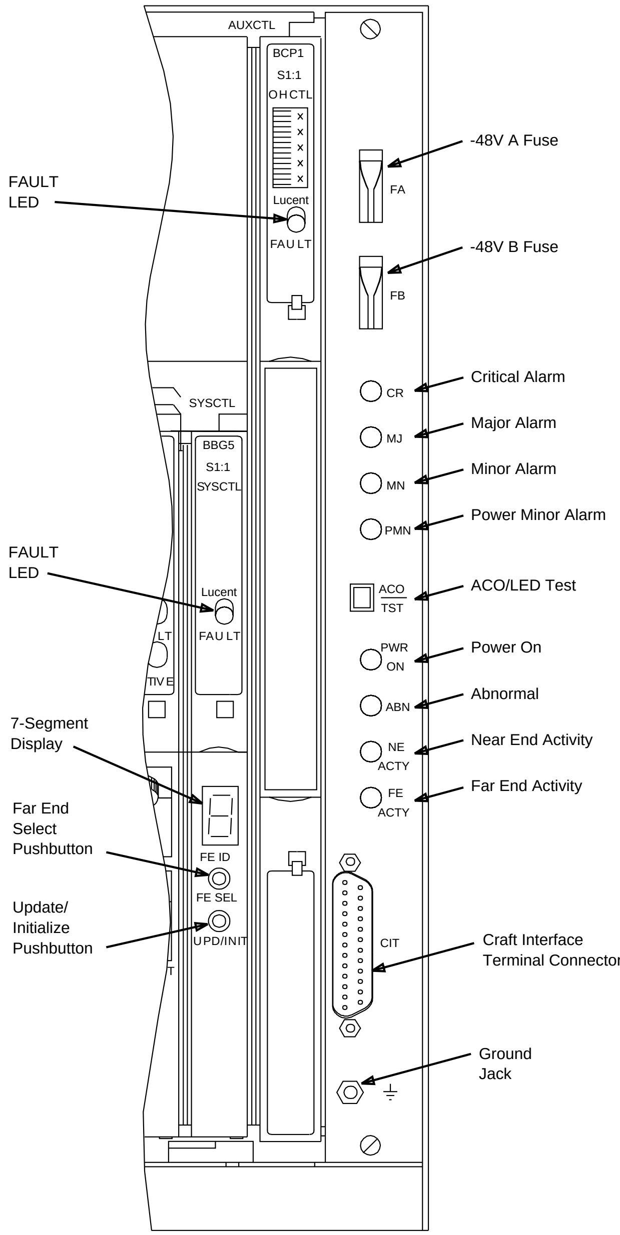


Figure 4-31. DDM-2000 OC-12 User Panel for Group 1 Shelf

The DDM-2000 OC-3 and OC-12 Multiplexer user panels for Group 4 Shelves are shown in Figure 4-32 and Figure 4-33, respectively. The G4 shelf user panels differ from G1 or G3 by the addition of Power ON LEDs for both A&B feeds.

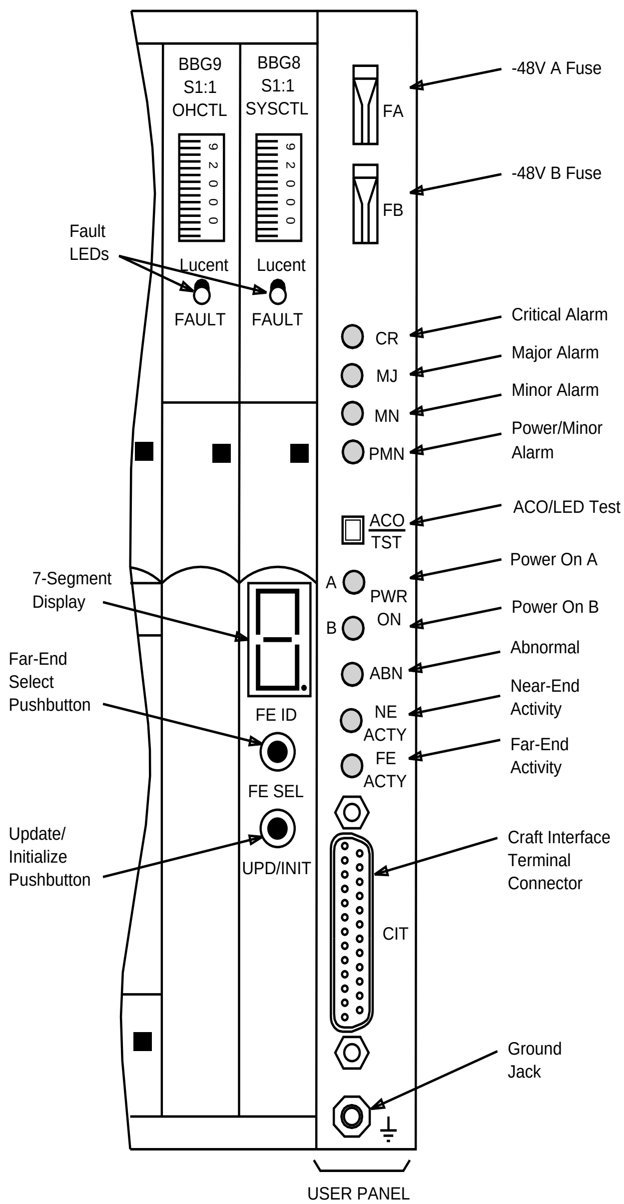


Figure 4-32. DDM-2000 OC-3 User Panel for Group 4 Shelves

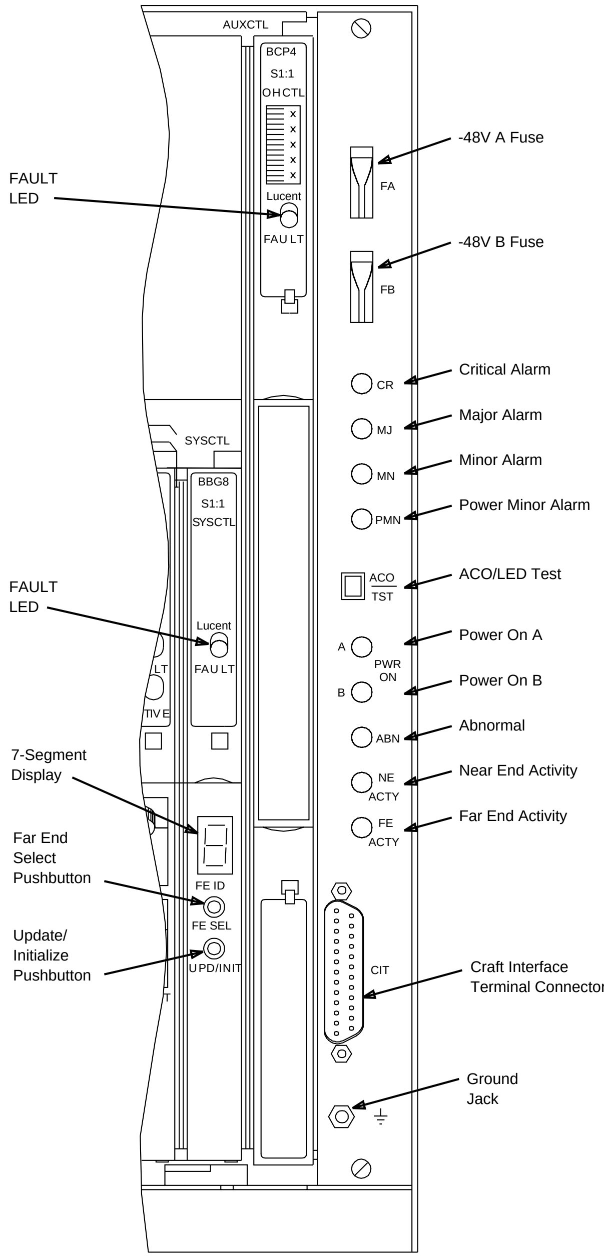


Figure 4-33. DDM-2000 OC-12 User Panel for Group 4 Shelves

Embedded Operations Channel

The technician and operations interface features extend beyond the local DDM-2000 Multiplexer to cover all associated remote DDM-2000 multiplexers in a subnetwork. This network operations capability uses the SONET section DCC bytes. Craft interface dialogs and operations interface messages travel in these DCC bytes on each OC-1, OC-3 or OC-12 interface.

Control Circuit Packs

DDM-2000 OC-3 Multiplexer

BBG5/BBG8/BBG8B System Controller (SYSCTL)

The BBG5/BBG8/BBG8B SYSCTL circuit pack provides functions required for basic operation of the DDM-2000 OC-3 Multiplexer. This includes a microprocessor, nonvolatile memory to store the generic program software and provisioning database, and additional memory for system operation. The BBG5/BBG8/BBG8B SYSCTL circuit pack also has interfaces across the backplane to monitor and control every circuit pack in the shelf.

The BBG8/BBG8B SYSCTL works with the BBG9 overhead controller for Releases 8.0 and higher. The BBG8/BBG8B provides additional memory and processing features needed for new features and applications and eliminates the need for DIP switches. Note that the BBG8 operates in integrated grounding (-48VRTN connected to frame ground) architecture systems. The BBG8B operates in either integrated or isolated grounding (-48VRTN not connected to frame ground) architecture systems.

The user interfaces to DDM-2000 are provided by the BBG5/BBG8/BBG8B SYSCTL circuit pack. Technician interfaces include user panel functions (7-segment numeric LED display, far-end select, and update/initialize), plus a red FAULT LED. Operations interfaces are office alarm, remote terminal (RT) miscellaneous discretes, and TBOS telemetry. Extensive DCC processing requirements are met by the overhead controller (OHCTL) circuit pack rather than the BBG5/BBG8/BBG8B SYSCTL circuit pack.

Among its environmental interfaces, the BBG5/BBG8/BBG8B SYSCTL circuit pack monitors the two –48 V power feeders. For remote cabinet installations, it contains a temperature sensor to control fan operation and monitors AC power and fan failure.

BBG7/BBG9 Overhead Controller (OHCTL)

The BBG7/BBG9 OHCTL circuit pack works in conjunction with the BBG5/BBG8/BBG8B SYSCTL circuit pack to provide the control hardware platform for all network topologies, from OC-3 hubbing and STS-1 drop through add/drop and path switched rings.

The BBG9 is the OHCTL that works with the new BBG8/BBG8B system controller for Releases 8.0 and higher releases. Like the BBG8/BBG8B, the BBG9 provides additional memory and processing features needed for new features and applications.

The BBG10 OHCTL is similar to the BBG9 with the addition of MegaStar 2000 E1 and multiplexed orderwire capabilities. The BBG10 requires Releases 8.1 (linear) or 9.1 (ring) to provide MegaStar 2000 capabilities. The BBG10 works in conjunction with the BBG8/BBG8B SYSCTL circuit pack.The BBG10 is required for *MegaStar* 2000 applications only.

Multispan applications require termination and processing of up to four section DCCs (hubbing). The OHCTL circuit pack supplies these DCC terminations as well as the TL1/X.25 OS interface. The OHCTL circuit pack also supports the CO parallel telemetry interface. Thus, the OHCTL circuit pack provides planners with more options as the OS network evolves toward message-based OSs.

DDM-2000 OC-12 Multiplexer

BBG5/BBG8/BBG8B System Controller (SYSCTL)

The OC-12 SYSCTL circuit pack is the same BBG5/BBG8/BBG8B SYSCTL used in the DDM-2000 OC-3 Multiplexer and provides functions necessary for the basic operation of the DDM-2000 OC-12 Multiplexer.

BCP1/BCP4 Overhead Controller (OHCTL)

The BCP1/BCP4 OHCTL circuit pack works with the BBG5/BBG8/BBG8B SYSCTL circuit pack to provide the control hardware platform for all network topologies such as hubbing, add/drop, and rings.

The BCP4 OHCTL works with the BBG8/BBG8B SYSCTL for Releases 5.0 and higher releases. Like the BBG8/BBG8B, the BCP4 provides additional memory and processing features needed for new features and applications and eliminates the need for DIP switches.

The BCP1 OC-12 OHCTL circuit pack provides the capability to process multiple (six) DCC channels and to route any of these channels to any of the line or drop slots that accept optical interfaces on the DDM-2000 OC-12 Multiplexer. Likewise, the BCP4 can process 10 DCC channels and also provides an IEEE 802.3 LAN interface. The BCP1/BCP4 OHCTL pack also provides the functionality needed for single-ended operations, as described in the following sections. The BCP1/BCP4 OHCTL circuit pack also supports a CO parallel telemetry interface, providing planners with more options as the OS network evolves toward message-based OSs.

Power

DDM-2000 OC-3 Multiplexer

The DDM-2000 OC-3 Multiplexer uses on-board power conversion eliminating the need for slots for bulk power converters. Two independent –48 volt office power feeders (A and B) enter the shelf through dangler cables (cables that come from the rear of the cabinet and "dangle" to provide front access to rear connectors), fused at the user panel, and distributed to the circuit packs. Power conversion is performed through modular power converters located on the circuit packs. In each circuit pack, the two feeders are diode ORed, fused, filtered, and regulated by the board-mounted power modules. This provides the required redundancy in case of the loss of one feeder or one fuse. Figure 4-34 shows the placement of these power converters. The power converter located on the MXRVO and STS1E circuit packs provides power to the DS1 circuit packs located in the corresponding multiplexer group.

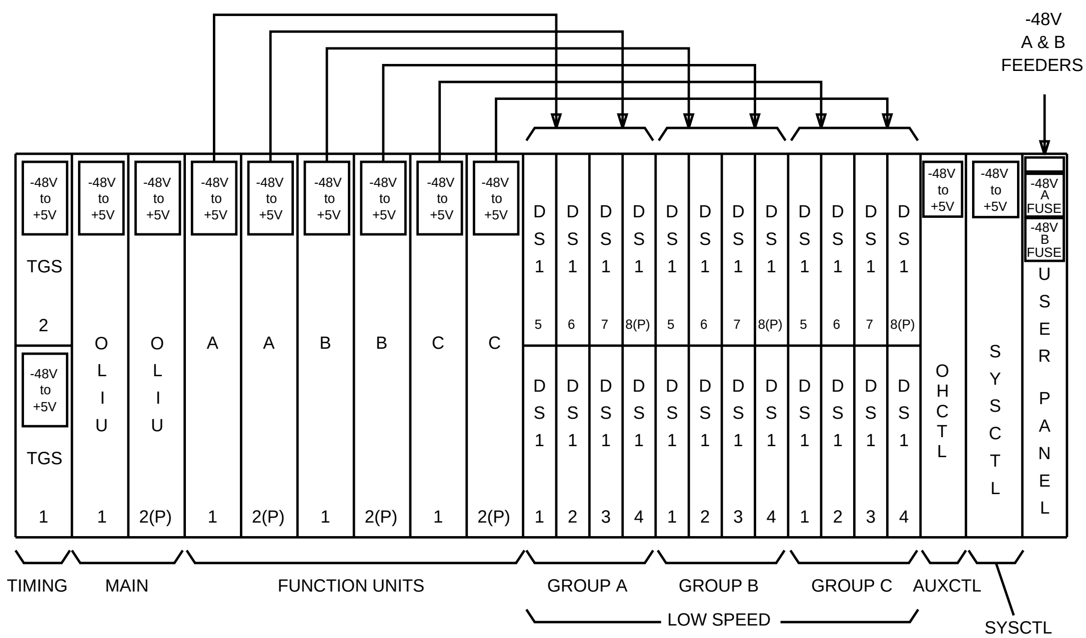


Figure 4-34. DDM-2000 OC-3 Multiplexer Power Architecture

Group 3 and Group 4 OC-3 Shelf Differences

- Group 4 has a user panel that has individual LEDs for the -48VA and -48VB power feeds. The group 3 has a user panel with only one LED for both power feeds.
- Group 4 backplane has connections between the service and protection slots of the function slot positions A, B and C. Group 3 does not have these additional connections and requires the use of a jumper pack to achieve these cross-connections.

Group 3 vs Group 4 OC-3 Backplane Grounding

Note the following differences between Group 3 and Group 4 backplane grounding:

- Group 3 has the -48VRTN (return), frame ground, and circuit ground tied together on the backplane. Group 4 has the frame ground and circuit ground tied together only on the backplane and requires that the -48VRTN be connected to frame ground at the -48V battery source.
- When using the BBG8 SYSCTL with the Group 4 shelf, the -48VRTN must be connected to frame ground at the source or the BBG8 will not self initialize.
- When using the BBG8B SYSCTL with the Group 4 shelf, alternative grounding methods can be used (the grounds can be tied independently).

DDM-2000 OC-12 Multiplexer

Like the DDM-2000 OC-3 Multiplexer, two independent –48 volt office power feeders (A and B) enter the shelf through backplane connectors, are fused at the user panel, and distributed to the circuit packs. Power conversion is performed through modular power converters located on the circuit packs. In each circuit pack, the two feeders are diode ORed, fused, filtered, and regulated by the board mounted power modules. This provides the required redundancy in case of the loss of one feeder or one fuse. Figure 4-35 shows the placement of these power modules.

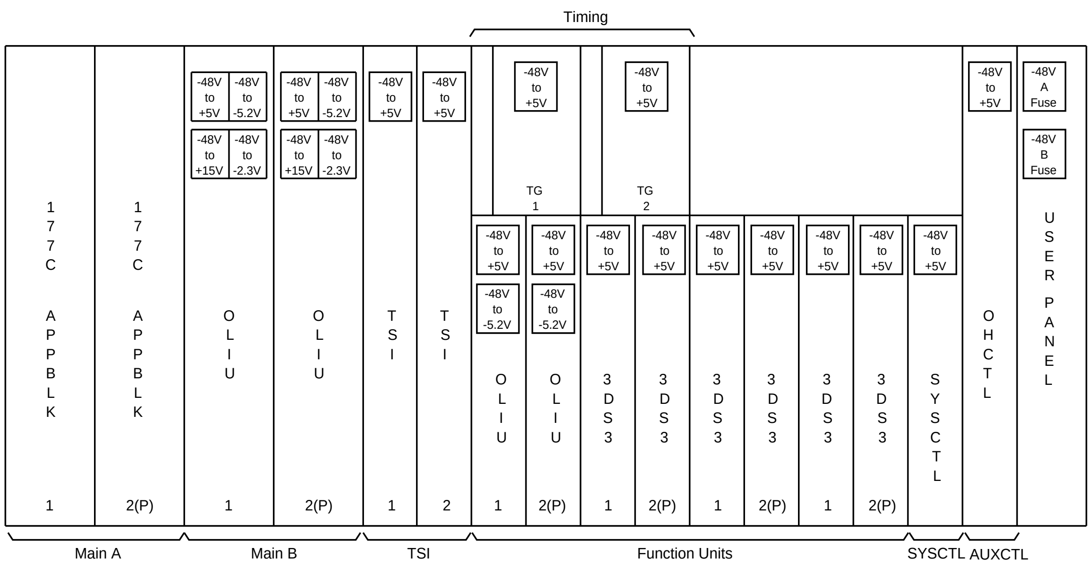


Figure 4-35. DDM-2000 OC-12 Multiplexer Power Architecture

Operations, Administration, Maintenance, and Provisioning

5

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5 Operations, Administration, Maintenance, and Provisioning

Overview

This section describes the operations, administration, maintenance, and provisioning (OAM&P) functions for the DDM-2000 OC-3 and OC-12 Multiplexers. Unless otherwise noted, all references to DS1 or VT1.5 processing refer only to the DDM-2000 OC-3 Multiplexer. Synchronous optical network (SONET) line, STS-1, EC-1, and DS3 signals are handled by both DDM-2000 OC-3 and OC-12 Multiplexers.

DDM-2000's OC-3 R13.0, R15.0, and OC-12 R7.0 introduce multi-vendor operations interworking (OI) compatibility using TARP instead of the Lucent Directory Service (LDS) protocol. See "Operations Interworking Using Target ID Address Resolution Protocol (TARP)" in this section for further information.

Maintenance

Single-Ended Maintenance Philosophy

A single-ended maintenance philosophy was originally incorporated in the design of the DDM-2000 Multiplexers as part of their optimization for operations in the subscriber loop. DDM-2000 Multiplexers allow operation and maintenance of all remote DDM-2000 Multiplexers in a subnetwork from a single shelf. Similarly, a technician working at a remote DDM-2000 site can gain access to other DDM-2000s in that subnetwork.

The DDM-2000 Multiplexers use the SONET data communications channel (DCC) to provide craft interface terminal (CIT) remote access, remote CO alarms, remote alarm reports, user panel remote access, remote OS access, and

telemetry remote access. In addition, OSs are available to allow operation of the DDM-2000 Multiplexers from a centralized operations center. The terms single-ended maintenance and single-ended operations (SEO) are synonymous and have traditionally been used to refer to operations among DDM-2000 systems only. Now that SEO is supported among the 2000 Product Family NEs as well as in multi-vendor applications, the term operations interworking (OI) is more commonly used. OI among multi-vendor NEs will be covered later in this chapter.

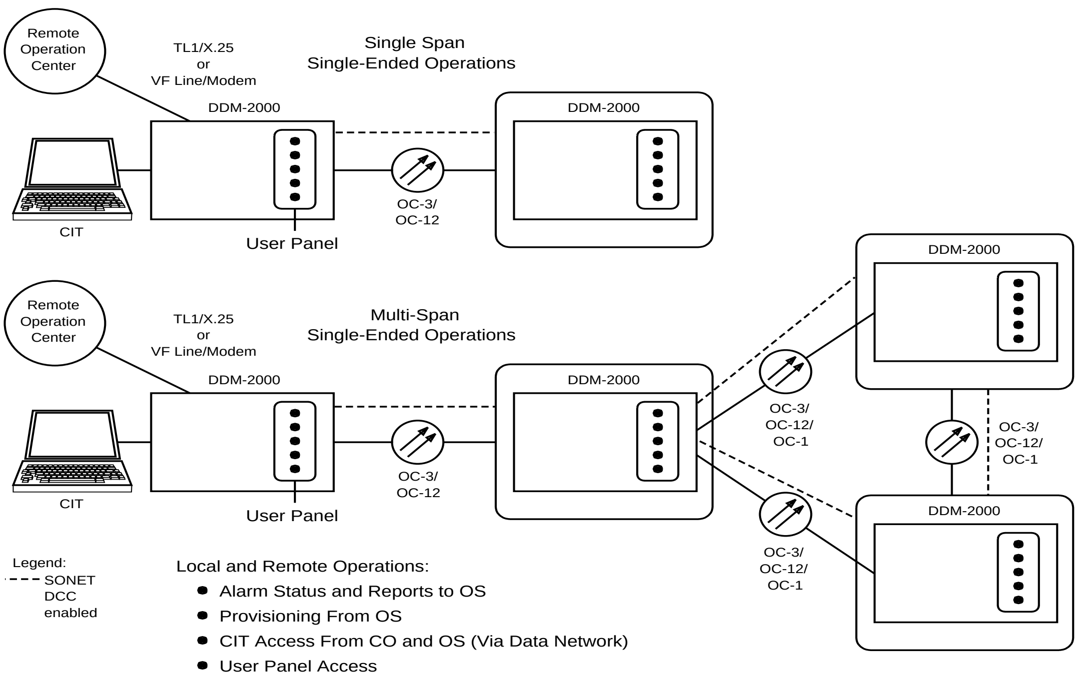

Figure 5-1. Single-Ended Maintenance Philosophy

Figure 5-1 shows the SEO capability that provides remote access to all DDM-2000 systems in a subnetwork from a single DDM-2000 location. This minimizes technician travel because most maintenance, provisioning, and administration can be performed on all DDM-2000 Multiplexers in a subnetwork by accessing any one DDM-2000. This capability is provided by the DDM-2000 Multiplexers in most subnetwork topologies. The SEO capability is supported for point-to-point, hubbing, rings, and rings with optical extensions topologies. The SEO capability can be disabled between DDM-2000 shelves to create subnetwork maintenance boundaries (for example, interoffice applications) or for security reasons.

Three-Tiered Operations

Figure 5-2 shows the three-tiered operations procedures for the DDM-2000 Multiplexers. The DDM-2000 Multiplexer operations procedures are built on three levels of system information and control, spanning operations needs from summary-level status to detailed reporting.

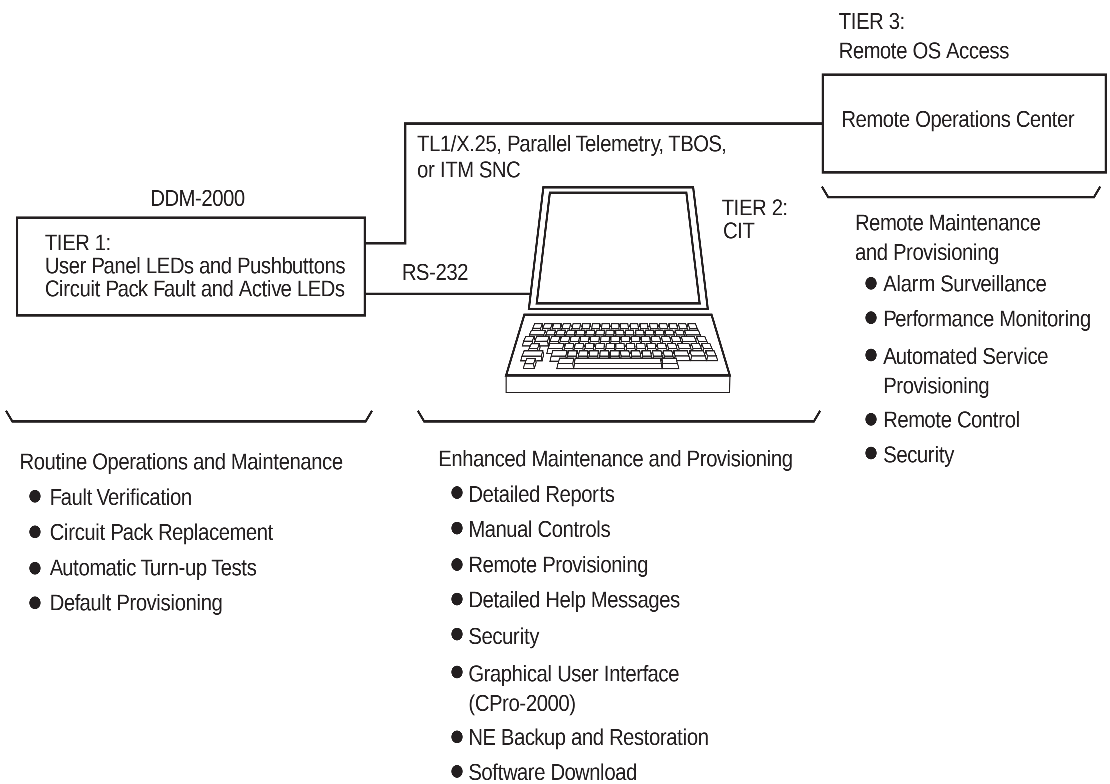

Figure 5-2. Three-Tiered Operations

User Panel and Faceplate LEDs (Operations Tier 1)

Office alarms are provided by a set of discrete relays that control office audible and visual alarms. Separate relays handle critical (CR), major (MJ), and minor (MN) alarms, although the CR and MJ alarms can be wired to the office major alarm, if desired. With the exception of DDM-2000 OC-3 R13.0 and OC-12 R7.0, office alarms can be remotely activated through the DCC from remote Lucent 2000 Product Family NEs.

The first operations tier consists of light-emitting diodes (LEDs) and pushbuttons on the user panel and circuit pack faceplates. These allow routine tasks to be performed without a craft interface terminal (CIT) or any test equipment. The user panel provides system-level alarm and status information for both the local and remote* terminals. The circuit pack faceplate FAULT LEDs allow fast and easy fault isolation to a particular circuit pack.

The user panel LEDs default to show local system information. The highest active alarm level is shown by the red LEDs for CR and MJ alarms; yellow LEDs are shown for MN and power minor (PMN) alarms. A green ACO button/LED is used to activate the alarm cutoff function. When activated, the LED is on. The green ACO button also initiates an LED test when the button is depressed and held. A green PWR ON (PWR ON A and PWR ON B for G4 shelf user panels) LED shows that the power is on and the terminal is receiving a –48 V source. Three yellow status LEDs show abnormal (ABN) conditions, near-end activity, and far-end activity*. The yellow ABN LED is lighted when a temporary condition, potentially affecting transmission, exists; for example, a manual protection switch or lockout, loopback, or system test in progress.

The UPDATE/INITIALIZE button addresses the local system and is located on the SYSCTL circuit pack. The recessed UPDATE/INITIALIZE button serves several functions during installation and circuit pack replacement, similar to the DDM-1000 Multiplexer's RST button. During the first 10 seconds after powering up the SYSCTL circuit pack, depressing this button initializes the nonvolatile memory with provisioning and state information. Secondly, after removing a circuit pack or low-speed input, depressing this button updates the system equipment list to show the slot or signal is now unequipped. Finally, a series of automatic turnup tests are initiated when the UPDATE/INITIALIZE and ACO buttons are depressed in a specific sequence.

The user panel's remote display functions (with the exception of DDM-2000 OC-3 R13.0 and OC-12 R7.0) serve the single-ended maintenance needs of loop applications. When any alarm or status condition exists at a remote DDM-2000

* Remote and far-end user panel functions are not supported in DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0.

OC-3/OC-12 Multiplexer, the FAR-END ACTIVITY LED on the user panel is lighted. The other user panel alarm and status LEDs, normally set to display composite network conditions, can be manually cycled, with the exception of DDM-2000 OC-3 and OC-12 TARP releases, to display the user panel LEDs from each remote site when the FAR-END SELECT push-button is depressed. A 7-segment numeric display above the FAR-END SELECT push-button identifies the remote system presently displayed on the local user panel LEDs. The display shows a hyphen (-) when the remote system's Site ID is greater than 8 (not applicable to all TARP releases). The FAR-END ACTIVITY LED and the FAR-END SELECT push-button are not operational in the OC-12 Regenerator because the OC-12 Regenerator is intended to be monitored from a centralized network maintenance and operations center.

To supplement the user panel's system-level view, each circuit pack provides a red FAULT LED on its faceplate. A lighted FAULT LED shows that the DDM-2000 Multiplexer has isolated a failure to that circuit pack. On transmission and synchronization circuit packs, a flashing FAULT LED shows that an incoming signal to that circuit pack has failed. The green ACTIVE LED shows the current protection switching states of the 1x1 protected circuit packs.

The DDM-2000 OC-3 and OC-12 Multiplexer user panels for Group 4 Shelves are shown in Figure 5-3 and Figure 5-4, respectively.

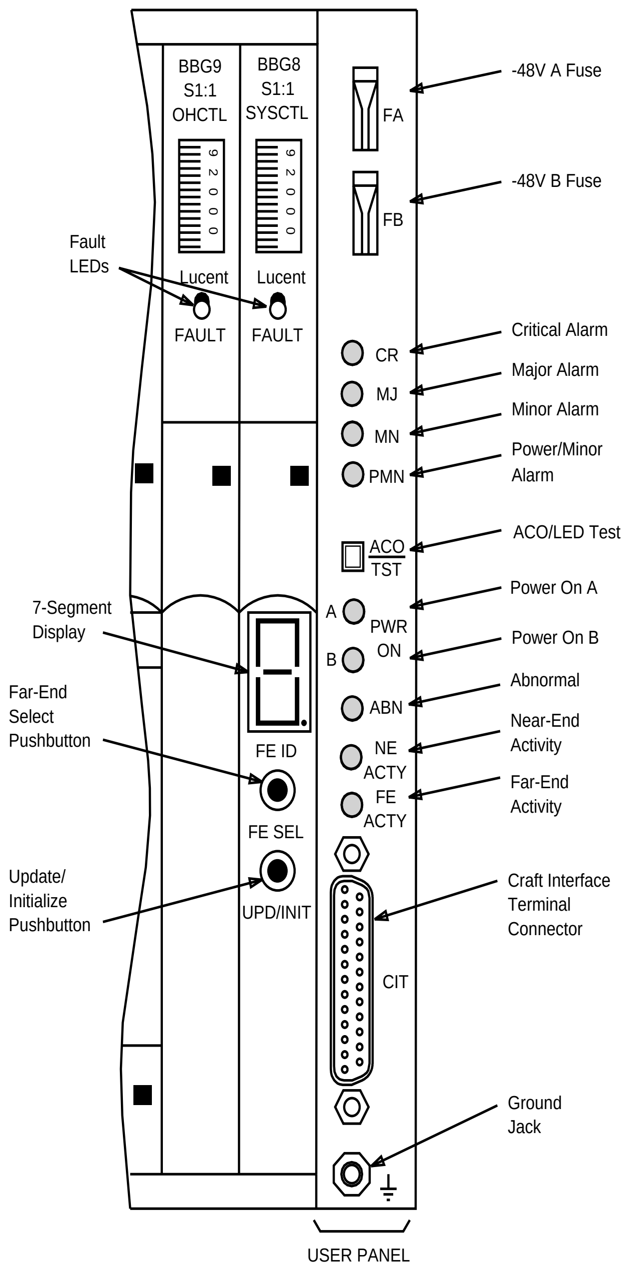

Figure 5-3. DDM-2000 OC-3 User Panel for Group 4 Shelves

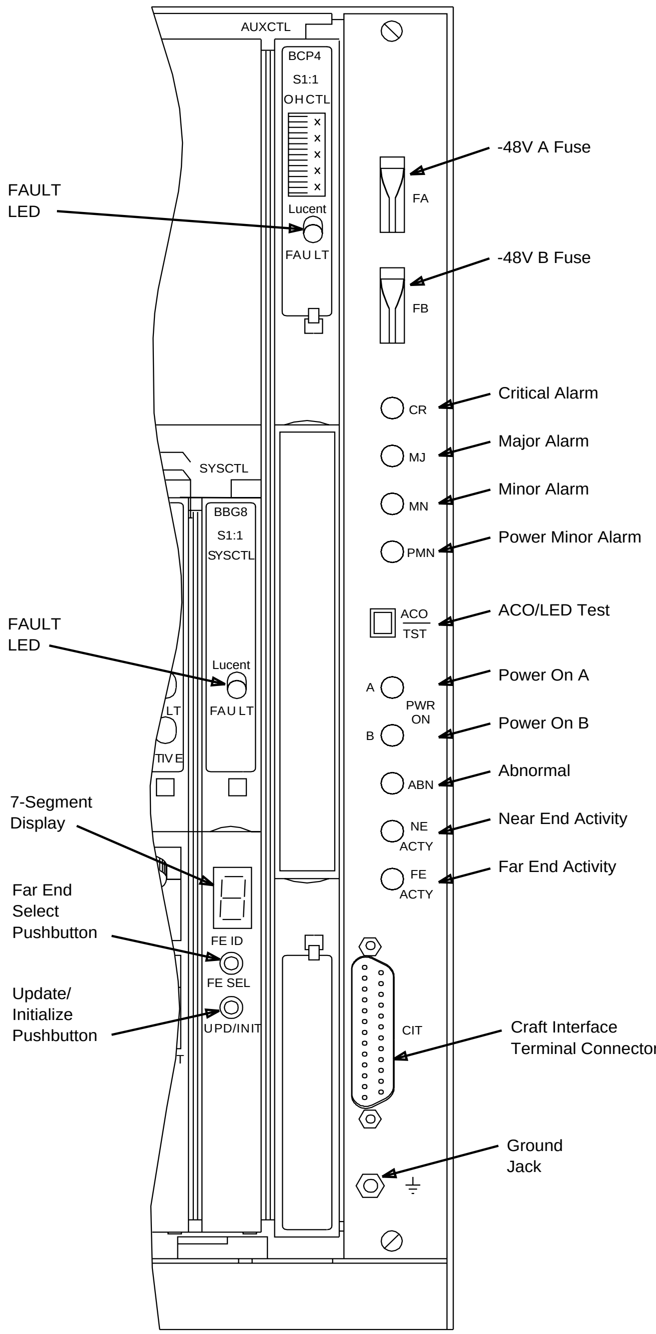

Figure 5-4. DDM-2000 OC-12 User Panel for Group 4 Shelves

Craft Interface Terminal (CIT) (Operations Tier 2)

The second operations tier provides access to DDM-2000 operations from a CIT over an EIA-232-D interface. System details that can not be obtained from the first operations tier alone can be obtained over the CIT interface. A VT-100 compatible terminal or terminal emulator software running on a PC can be used as a CIT. The dialog is CCITT/ANSI MML-compliant and provides both prompt and command modes with extensive on-line help features for assistance in command execution.

The CIT interface supports OAM&P activities such as loopbacks and testing, protection switching, provisioning, PM, retrieving reports, and security on any and all DDM-2000 Multiplexers in a subnetwork from a single DDM-2000 or FT-2000. The local DDM-2000 or FT-2000 CIT alarm reports may include far-end summary alarm information about other Lucent NEs in the same subnetwork. Access to remote DDM-2000 Multiplexers is supported via CIT remote login.

The DDM-2000 OC-3 and OC-12 Multiplexers have both front and rear access CIT ports compatible with the EIA-232-D standard. The front access port is configured as a data circuit terminating equipment (DCE) for direct terminal access. The rear access CIT port is configured as a data terminal equipment (DTE) to allow a permanent modem connection without requiring a null modem. Both CIT ports provide data rates of 300, 1200, 2400, 4800, 9600, and 19200 baud.

Multiple DDM-2000 OC-3 and OC-12 Multiplexers in a bay can be linked. This allows a terminal connected directly to one shelf in a bay to access any shelf in that bay. This includes bays that have both DDM-2000 OC-3 and OC-12 Multiplexers.

An optional graphical user interface (CPro-2000) software tool used with a PC is also available.

— CPro-2000 is a Windows-based graphical user interface that allows a user to obtain common graphical look-and-feel for DDM-2000, *SLC*-2000, and FT-2000 products while continuing to have full access to the ASCII CIT and/or TL1 interfaces of those SONET products. CPro-2000 also mechanizes several tasks such as end-to-end path provisioning in path and line switched rings and provides an NE database backup and restoral feature. The CIT ports of the previously mentioned SONET products can be accessed remotely over data networks and/or dial up modems. Consequently, a user can access all Tier 2 operations using just a terminal or CPro-2000 locally or remotely. See Section 11, "Technical Specifications," for hardware and software needed to use CPro-2000. See 190-523-101 and/or 365-576-1xx, *CPro-2000 User Manual*, for more information.

Operations System (OS) Interface (Operations Tier 3)

The third operations tier consists of the remote OS interfaces. These OS interfaces include parallel telemetry, telemetry byte-oriented serial (TBOS), miscellaneous discrete telemetry, TL1/X.25, and an IAO LAN interface.

Parallel Telemetry

Parallel telemetry (for Lucent Directory Services (LDS) releases **prior to** TARP releases OC-3 R13.0,R15.0, and OC-12 R7.0) brings a minimum set of alarm and status information to an operations center. Four alarm closures indicate CR, MJ, MN, and power minor alarms (PMN) at the local or remote DDM-2000 Multiplexer. Status closures identify these alarms as either near-end or far-end. Other status closures indicate failures in the incoming OC-3 or OC-12 signal or incoming low-speed interfaces and system identification when alarms are combined among several shelves in a bay. These are not “dry” contact closures. They can handle a limited amount of current and are polarized to operate with the proper voltage polarity. Also, a remote DDM-2000 OC-12 Regenerator may be maintained by remoting the parallel telemetry alarm and status information, using the miscellaneous discretes on co-located equipment at the remote terminal site.

Serial Telemetry

Serial telemetry (for Lucent Directory Services (LDS) releases **prior to** TARP releases OC-3 R13.0, R15.0, and OC-12 R7.0) is provided using the TBOS protocol. TBOS telemetry offers detailed alarm, status, and control (AS&C) information to and from a remote maintenance center, via a 2400-baud RS-422 port. The TBOS AS&C link can be shared among multiple DDM-2000 networks. Since a link has eight displays and each shelf requires one display (each display provides 63 information points [DDM-2000 OC-3 and OC-12 to OS] and 64 control points [OS to DDM-2000 OC-3 and OC-12]), any combination of DDM-2000 OC-3 and OC-12 Multiplexer shelves, not exceeding eight, can be supported on one AS&C link.

Miscellaneous Discretes

The user-definable miscellaneous discrete interface transports alarm and status information from co-located equipment at remote sites. At each remote site, a total of 21 alarm/status inputs (OC-3 R8 and later, OC-12 R5 and later required; previous releases and the BBG5 controller supports 15) are available to monitor environmental conditions like open doors or high temperature. A change in the monitored condition generates an autonomous alarm/status message through the TL1/X.25 OS interface. Twenty of these inputs are user-assignable, while the fifteenth point is dedicated to the AC/DC rectifier and fan equipment used in most

remote sites. Each user-assignable input is provisionable with a name and a status condition or a MN, MJ, or CR alarm. A separate discrete power minor input also triggers an alarm when, for example, a remote site has switched from AC power to DC battery reserves. Four control outputs are also provided at each remote site to control auxiliary equipment like generators and pumps.

When equipped for parallel telemetry (prior to DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0), the remote miscellaneous discrete closures map to nine discrete alarm/status outputs and four control inputs at the associated CO shelf. When using serial telemetry (Releases prior to DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0), the remote alarm/status points 1 through 15 and the four control closures are mapped into each system's remote TBOS display.

TL1/X.25

DDM-2000's TL1 message-based OS interface provides more detailed reporting and control capabilities than the parallel and serial telemetry interfaces. The interface uses the standard X.25 protocol and needs no mediation device; that is, the interface can be connected directly to an X.25 network. The virtual channels in the X.25 link can be used to provide remote access between users and DDM-2000 via a packet data network. The remote user could be an OS or a user at a terminal. Lucent Technologies is involved in an active OSMINE process to ensure compatibility of DDM-2000 OC-3 and OC-12 Multiplexers with Telcordia Technologies OSs. The DDM-2000 supports TL1 alarm surveillance and performance monitoring with OSs such as Telcordia Technologies Network Monitoring and Analysis (NMA). The DDM-2000 supports service provisioning with memory administration OSs such as Lucent's ITM SNC* or Telcordia Technologies OPS/INE. The DDM-2000 also supports remote recovery and control functions, installation provisioning, and security over the TL1/X.25 link. The TL1 message set used has been updated to offer full remote reporting and control capabilities. This functional equivalency between the CIT and TL1 allows the option of using either the CIT or TL1 for provisioning tasks, whichever is more convenient. Beginning with DDM-2000 OC-3 Release 8.0 and DDM-2000 OC-12 Release 5.0, all the CIT provisioning capabilities can also be done over the TL1 interface. See 824-102-151, *DDM-2000 Multiplexers Operations Systems Engineering Guide,* for more information about OS interfaces.

The *SLC*-2000 Access System supports the same X.25 interface and TL1 message set as the DDM-2000 OC-3 Multiplexer. Newer releases of the *SLC*-2000 Access System add digital loop carrier (DLC) specific functionality in the existing messages (for example, for DLC related alarms) and in addition support DLC specific commands (for example, DS0 level provisioning).

* The Integrated Transport Management SubNetwork Controller (ITM SNC) is an element management system that supports SONET NEs. ITM SNC provides fault, provisioning, configuration, and security management functions via a GUI.

See 363-208-000, *SLC-2000 Access System, Applications, Planning, and Ordering Guide*, for more information.

The OS can use more than one NE as a GNE to provide redundancy and/or to distribute TL1 message volume across multiple X.25 links. The TL1/X.25 GNE serves as a single interface to the OS for the NEs in the same subnetwork. The TL1/X.25 GNE receives operations information from all the NEs through the DCC and reports this information, as well as its own information, to the OS. The operations information is in the form of TL1 messages. Through the GNE, the OS can send TL1 commands to any NE in the subnetwork. FT-2000 OC-48 Lightwave Systems can serve as the TL1/X.25 GNE for DDM-2000 NEs, but not vice versa, except for DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 which can be the GNE for FT-2000 NEs. For DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0, Tellabs TITAN 5500/S R5.0 DCS, or other-vendor NEs that adhere to Telcordia Technologies GR-253, can be the TL1/X.25 GNE also. Or, Lucent's ITM SNC can serve as the TL1/X.25 GNE for DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0.

IAO LAN Interface

DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 support an IntrAOffice LAN (IAO LAN) interface for operations data communications. The IAO LAN is necessary to support the following ITM SNC R5.0 features:

- ITM SNC as the TL1-GNE for DDM-2000
- ITM SNC software download to DDM-2000.*

Because the IAO LAN is effectively an extension of the SONET DCC, the IAO LAN may also be used to join multiple, otherwise separate subnetworks. All NE-to-NE OI features that are supported by DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 over the DCC are also supported over the IAO LAN.

The IAO LAN interface is a software-only enhancement to DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0. The current DDM-2000 overhead controller (OHCTL) circuit packs already support the IAO LAN interface (via an RJ45 connector). DDM-2000's IAO LAN interface is compatible with 10BaseT Ethernet hubs operating at 10 Mb/s over 4-wire twisted pair cables (per Telcordia Technologies GR-253, ANSI/IEEE 802.2 [ISO 8802-2] and ANSI/IEEE 802.3 [ISO 8802-3]).

* This feature will be useful when upgrading from DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 to subsequent releases.

Lucent 2000 Product Family OI

OI provides the capability to access, operate, administer, maintain, and provision remote Lucent NEs from any Lucent NE in a subnetwork or from a centralized OS. OI among the Lucent 2000 Product Family uses Lucent Directory Services (LDS) and is applicable for DDM-2000 OC-3 Releases 7.2 through 11.x and OC-12 Releases 5.x.

Other Lucent NEs that support OI include FT-2000 OC-48 Lightwave System, DDM-2000 FiberReach Multiplexer, and the *SLC*-2000 Access System. For OI release compatibility information refer to the “OI Networking Software Compatibility” matrix, Table 5-4, in this section. More OI information is provided in 824-102-147, *Lucent Technologies 2000 Product Family, Operations Interworking Guide*.

Lucent 2000 Product Family OI is available among Lucent NEs that are connected through the SONET DCC in Lucent-only subnetworks. With this feature, users can do OAM&P on a centralized basis, saving travel time and money.

Lucent 2000 Product Family OI features include the following:

- Remote OS access
  - Parallel telemetry *
  - Serial telemetry *
  - TL1/X.25
- Remote login (remote technician access)
- Remote office alarms, alarm CIT reports and user panel
- Remote software download and copy

Directory Services Network Element (DSNE)

Lucent's 2000 Product Family supports open systems interconnection (OSI) 7-layer protocol stack architecture over the SONET DCC. This architecture requires network layer 3 identifiers called network service access points (NSAPs) for addressing NEs, while users at remote OSs and at NE CITs use application layer 7 identifiers called target identifiers (TIDs). The NE in each Lucent 2000 Product Family subnetwork that translates between NSAPs and TIDs is called the directory services network element (DSNE) (with the exception of DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0). The maximum number of DSNEs per subnetwork is 1.

Any Lucent NE in a subnetwork except a FiberReach node can act as a DSNE. Lucent 2000 Product Family NEs added to a subnetwork are automatically registered by the DSNE and have access to all OI features.

* Excluding DDM-2000 OC-3 R13.0, R15.0 and DDM-2000 OC-12 R7.0.

Alarm Groups

An alarm group is a set of NEs that share status information between themselves. Before DDM-2000 OC-3 Release 7.2 and OC-12 Release 5.0, when subnetwork sizes were smaller, every NE broadcast its status to all other NEs. This status information included:

- Alarm/status level
- User panel status
- ACO status
- TBOS status
- Parallel telemetry status
- Miscellaneous discrete information

The set of remote NEs that an NE can exchange status information with is determined by the value of the local alarm group parameter. This parameter is provisioned at each local NE and specifies whether that local NE does or does not exchange remote NE status with other Lucent NEs in the same SONET subnetwork. In DDM-2000 OC-3 R7.2 through R11.x, R15.0, and OC-12 R5.x all NEs are defaulted into the same alarm group (number 255).

Alarm groups can be nodes in a ring, nodes of a linear extension, nodes of an OC-12 service, or any other logical grouping such as a maintenance group or geographical group. For example, 24 NEs could be provisioned into three alarm groups each with eight NEs that share a community of interest such as the same TBOS interface (TBOS not applicable to DDM-2000 OC-3 R13.0, R15.0 and DDM-2000 OC-12 R7.0).

All members of the same alarm group share NE status information but do not share information with other alarm groups.

Depending on provisioning, a member of an alarm group can:

- Know the alarm/status of all members of the same alarm group and, if the NE is at the CO, activate audible office alarms for the alarm group.
- List a report of the summary alarm or status condition of other NEs in the group.
- Display composites of other members’ user panel information. If the site identification of a remote NE is from 1 to 8, display the user panel status at the site instead of a composite display. As a feature, the same site/NE identification can appear more than once in a subnetwork, as long as, it is in different alarm groups. This supports creating large networks by interconnecting several small subnetworks without having to change the site/NE identification. This feature is not applicable to DDM-2000 OC-3 R13.0, R15.0 and DDM-2000 OC-12 R7.0.

- Relay other members' parallel and/or serial telemetry alarm/status closure states to the OS (not applicable to DDM-2000 OC-3 R13.0, R15.0 and DDM-2000 OC-12 R7.0).
- Send and receive miscellaneous discrete alarm/status closure states to and from alarm group members at a CO.
- Send and receive ACO requests to and from members of the same alarm group with the same site number. This supports the ability for a user to activate ACO for a group of NEs having the same site number and subnetwork connectivity to another member NE in the group (not applicable to DDM-2000 OC-3 R13.0 and DDM-2000 OC-12 R7.0). In DDM-2000 OC-3 R15.0, only local ACO is supported.

Alarm Gateway Network Element (AGNE)

Members of an alarm group exchange information through one or more alarm gateway NEs (AGNEs) (with the exception of DDM-2000 OC-3 R13.0 and OC-12 R7.0) that are defined in the same alarm group. The AGNE(s) and remote NEs use the DCC to receive and report alarm and status information from and to all Lucent NEs in the same alarm group. The AGNE rebroadcasts all alarm and status information from one NE to all the other NEs in the same alarm group. This information is used to activate remote user panel LEDs, CIT far-end summary alarm reports, and remote office alarms for each NE in the alarm group. At least one NE in each alarm group must be provisioned as the AGNE; an additional AGNE can be provisioned for redundancy. Considerations for choosing an NE as an AGNE include being central to the group to minimize communications links and being easily accessible for maintenance purposes.

For subnetworks having more than 16 NEs, the AGNE, DSNE and TL1/X.25 GNE should be separate NEs. The AGNE is a "collection point" and does not have to be a NE in a CO, for example.

Multi-Vendor OI

To support multi-vendor OI, DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 support Target ID Address Resolution Protocol (TARP) instead of Lucent Directory Service (LDS). DDM-2000 FiberReach R3.0 or later, TRCU3 R13.5, and FT-2000 OC-48 R8.1 or later also support TARP, thus Lucent 2000 Product Family OI compatibility is still supported, but OI compatibility with previous releases of DDM-2000 and FT-2000 is not supported (see OI Software Compatibility, Table 5-4). Both LDS and TARP are directory services that provide NSAP-TID translations. LDS supports additional Lucent-only features, but TARP is the established multi-vendor standard for SONET NEs that support TL1 OS interfaces. DDM-2000 supports the TARP Data Cache (TDC) function to reduce the frequency of TARP propagation throughout the subnetwork and to improve performance. No DSNE is required for TARP.

DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 are developed to be compatible with any other-vendor NEs that also support TARP, OSI, IAO LAN, and TL1/X.25 as specified in Telcordia Technologies GR-253. In addition, DDM-2000's TARP Manual Adjacency feature enables DDM-2000 to operate in networks that include CMISE-based NEs which may not support TARP propagation. DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 support user provisioning of several OSI parameters to allow users to adjust their operations subnetwork, if necessary. For example, to support subnetwork partitioning of large subnetworks, DDM-2000 supports user provisioning of NSAP area addresses and Level 2 Intermediate System (IS) functionality.

DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0's compatibility with Tellabs *TITAN* * 5500 DCS R5.0, including TL1/X.25 OS access with TITAN 5500 DCS serving as the TL1-GNE for DDM-2000 TL1-RNEs, has been confirmed through cooperative joint testing between Lucent and Tellabs. DDM-2000's compatibility with some other-vendor NEs has also been tested by independent third-parties such as Telcordia Technologies on behalf of the SONET Interoperability Forum (SIF).

Because DDM-2000 OC-3 R13.0, and OC-12 R7.0 are intended to facilitate OS-based centralized operations, and because TL1/X.25 OS access is the key standardized multi-vendor OI application, the following Remote NE Status features are not supported in DDM-2000 OC-3 R13.0, and OC-12 R7.0:

- Remote office alarms
- Remote CIT alarm reports
- Remote user panel indications
- TBOS
- Parallel telemetry.

The following Remote NE Status features are not supported in DDM-2000 OC-3 R15.0:

- Remote user panel indications
- TBOS
- Parallel telemetry.

All of the above features depend on the proprietary exchange of information among Lucent NEs in a subnetwork, specifically the communication of each remote NE's alarm status to other NEs. Although the Remote NE Status features were supported in previous releases of DDM-2000, such Lucent-only operations features in multi-vendor subnetworks would not include other-vendor NEs, due to the lack of applicable standards, and thus would be incomplete.

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* *TITAN* is a trademark of Tellabs, Inc.

DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 still support the following Lucent proprietary OI applications between Lucent NEs in multi-vendor subnetworks:

- Remote Craft Interface Terminal (CIT) login
- Remote software download and copy
- Remote NE-to-NE automatic time/date synchronization at start-up.

For more information about DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 OI, refer to 824-102-144, *Lucent Technologies 2000 Product Family, Multi-Vendor Operations Interworking Guide.*

Software Download and Copy

The DDM-2000 OC-3 and OC-12 Multiplexers can upgrade the system software while in-service. DDM-2000 OC-3 and OC-12 Multiplexers use flash erasable programmable read-only memory (flash EPROM) chips to store the system software. System software can be downloaded using a PC (see specifications in Section 11) through the EIA-232-D interface on the user panel into the local system, or to another system connected to the local system via the SONET DCC. The PC can also download the system software from a remote location as long as access to the target system is available via a data network, either directly to the EIA-232-D interface of the target system, or to that of any other system connected to the target system via the SONET DCC. In addition, system software can be copied between like systems connected by the SONET DCC. The remote software download and copy capabilities enable the network service providers to avoid costly craft dispatches for software upgrade.

The DDM-2000 OC-3 and OC-12 systems accept downloads without disrupting transmission and with minimal impact on operation functions. This enables the software upgrades to be transparent to the transmission services and to the network operations. DDM-2000 OC-3 R9.1, DDM-2000 OC-12 R5.1, and later, accept the downloading of compressed, dormant software copies. These copies are not activated immediately, but instead await an “`apply`” command that activates the dormant software 30 minutes later. DDM-2000 OC-3 R11.0 and OC-12 R7.0, and later, accept an `apply` command that can be scheduled to be applied at any time the user specifies. This reduces the time that incompatible NEs would be isolated during cut-over to a new software release and reduces the total time required to upgrade a subnetwork.

DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 provide enhanced software download and copy capabilities which allow compressed files containing the new software generic to be downloaded to the DDM-2000 system while the current version is still running without affecting the operation of the system in all cases.

DDM-2000 can also accept software downloads from Lucent’s ITM SNC R5.0 when upgrading from DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 to subsequent releases.

DDM-2000 IMA LAN R1.0 provide enhanced IMA LAN software download and copy capabilities which allow compressed files containing the new IMA LAN software generic to be downloaded to the LAN circuit packs while the current version is still running without affecting the operation of the system in all cases.

DDM-2000 can also accept software downloads from Lucent’s ITM SNC R5.0 when upgrading from DDM-2000 IMA LAN R1.0 to subsequent releases.

Maintenance Signaling

Alarm indication signals (AIS) are maintenance signals that notify equipment downstream from a failure that the failure has been detected and alarmed by some upstream equipment and notify upstream equipment to initiate trunk conditioning because of a downstream detected failure (yellow signals).

Maintenance signaling is compliant with SONET (Telcordia Technologies TR-TSY-000253) and asynchronous (Telcordia Technologies TR-TSY-000191) network requirements. Alarm indication signals include SONET line AIS, STS-1 path AIS, virtual tributary (VT) path AIS, DS3 AIS, and DS1 AIS. Yellow signals include STS-1 path yellow and VT path yellow. Other maintenance signals include line far-end-receive failure (FERF), STS-1 path unequipped, and VT path unequipped.

Fault Detection, Isolation, and Reporting

The DDM-2000 OC-3 and OC-12 Multiplexers continuously monitor incoming signals and internal system conditions. Incoming SONET signals are monitored for loss of signal (LOS), loss of frame (LOF), loss of pointer (LOP), line AIS, path AIS (rings only), bit error ratio (BER) thresholds and maintenance signals. The LOS and BER threshold crossings are detected for incoming DS1 (DDM-2000 OC-3 Multiplexer only), DS3, OC-3, and STS-1 signals.

When an internal fault is detected, automatic diagnostics isolate the faulty circuit pack. Faults are reported to local technician and operations systems so that technician dispatch and repair decisions can be made. If desired, OS personnel and local technicians can use the CIT to gain more detailed information on the fault condition.

All fault conditions detected by the system are stored and made available to be reported, on demand, through the CIT. In addition, a history of past alarm and status conditions and CIT events is maintained and available for on-demand reporting. Each event is real time and date stamped.

The system also automatically and autonomously reports all detected alarm and status conditions through the office alarm relays, user panel and equipment LEDs, parallel telemetry, serial telemetry scan points, and TL1 message-based OS interface.

Loopbacks and Tests

The DDM-2000 OC-3 and OC-12 Multiplexers allow technicians to perform loopback tests on all low- and high-speed interfaces. Low-speed DS1 (not available on OC-12), DS3, and STS-1 electronic loopbacks, directed toward the high-speed OC-3 or OC-12 line (terminal loopback), are individually controllable from the CIT, and for OC-3 Release 8.0 and later, and OC-12 Release 5.0 and later, from the TL1 interface also. Active electronic loopbacks are shown by the abnormal (ABN) LED on the user panel and in the alarm and status report. STS-1 and DS3 facility loopbacks toward the DSX are also available.

Front access to the optical connectors on the optical line interface unit (OLIU) circuit pack allows easy manual optical loopback. This loopback is performed by connecting a fiber jumper from the OLIU circuit pack output to its input. In some cases a lightguide buildout assembly is required to prevent receiver overload when performing loopbacks. See Table 4-3 in the “Product Description” section of this manual for more information.

Technicians can use the internal testing capabilities for installation and manual troubleshooting. The DS1 and DS3 test signal generators and detectors are integrated in the system, eliminating the need for external test equipment to perform transmission tests.

The DDM-2000 OC-3 and OC-12 Multiplexers have three integrated installation tests to simplify system installation. These tests can be controlled using the user panel or the CIT. Three different installation tests are provided:

1. Local Equipment Test — Tests the local DDM-2000 OC-3/OC-12 equipment, the high-speed signals are looped back (manual optical loopback) towards the low-speed interfaces.
2. Local Wiring Cross-Connect Test — Tests the wiring to the local cross-connect panel, all low- and high-speed signals are looped back (manual loopbacks at the DSX).
3. Optical Span Test — Tests the transmission across the optical interfaces, the OC-3 signals are monitored at both ends of the optical span.

Each test returns a good/fail result. The test results are also reported to the CIT at the end of the test. Any failure detected during the tests is shown by lighting the FAULT LED on the failed circuit pack. If the wiring to the cross-connect is defective, the FAULT LED on the low-speed interface circuit pack(s) that detect(s) an incoming signal failure blinks for 1 minute. If the test passes, the ACO LED is lighted for 1 minute. These tests currently can not be used in ring applications.

The DDM-2000 OC-3 and OC-12 Multiplexers also allow technicians to test for specific signals and system components. For example, technicians can manually enable the integrated test signal generators and detectors for a DS1 or DS3 low-

speed interface. These signal tests can be run selectively in the end-to-end or demultiplex direction. In addition to the automatic diagnostics, the DDM-2000 OC-3 and OC-12 Multiplexers also provide tests for LEDs, telemetry points, office alarms, and the system controller (SYSCTL) circuit pack.

Electrical Facility Loopbacks

DS3 and EC-1 loopbacks of the incoming low-speed signals back to the DSX are supported in DDM-2000 OC-3 Multiplexers Release 8.0 (linear) and 9.0 (rings) and later releases, and OC-12 Multiplexers Release 5.0 (rings) and later releases. DS3 and EC-1 loopbacks on the low-speed circuit packs are individually controllable from the CIT or from the TL1 interface. Quad DS1 loopbacks (of the four DS1 interfaces per low-speed circuit pack) of the incoming low-speed signals back to the DSX are supported in DDM-2000 OC-3 Releases 9.1 and 11.0. Individual DS1 facility loopbacks are supported beginning with Releases 13.0 and 11.1 and using the BBF3B DS1PM circuit pack.

OC-12 Regenerator Operations and Maintenance

The following paragraphs provide operations and maintenance information for the OC-12 Regenerator.

Figure 5-5 shows the OC-12 Regenerator interfaces. Operations and maintenance of a system with OC-12 Regenerators are similar to that of a point-to-point DDM-2000 OC-12 Multiplexer system. Since the OC-12 Regenerator accesses only the physical layer of the SONET signal, maintenance is simplified compared to the DDM-2000 OC-12 Multiplexer. Both local and remote maintenance of the OC-12 Regenerator are possible. As with the DDM-2000 OC-12 Multiplexer, local maintenance is provided by the circuit pack LEDs, the user panel, office alarms, and CIT access.

The OC-12 Regenerator uses the SONET optical performance parameters to detect local circuit pack failures as well as incoming signal failures. An OC-12 Regenerator circuit pack failure causes the FAULT LED on the failed circuit pack to light, as well as the NE ACTY LED and the critical alarm on the user panel. The appropriate local office alarm will be activated, and the failure reported to the message-based OS via the telemetry byte-oriented serial (TBOS), parallel telemetry, or TL1/X.25 interface.

Incoming loss of signal (LOS) or alarm indication signal (AIS) are detected at the OC-12 Regenerator and cause the FAULT LED on the affected circuit pack to flash. The LOS and AIS are passed through the OC-12 Regenerator transparently and are detected and alarmed at the downstream terminal multiplexer. The terminal multiplexer performs the line protection switching if required. The OC-12 Regenerator does not insert line AIS, since it only accesses the physical layer of the OC-12 signal. Also, since the OC-12 signal is passed through the OC-12

Regenerator transparently without accessing the SONET overhead, the DCC bytes are not processed.

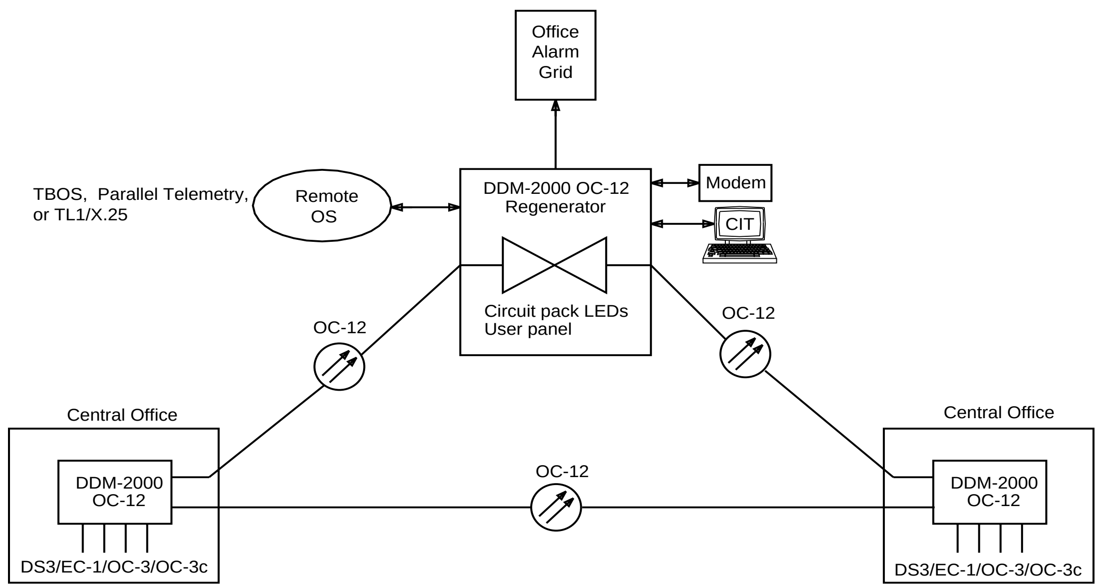

Figure 5-5. OC-12 Regenerator — Operations Interfaces

The 23R-U REGENR circuit pack detects BIP-8 errors (BIP-8 is part of the SONET line overhead) at each OC-12 Regenerator and produces counts of BIP-8, errored seconds, and severely errored seconds for each 15-minute interval. Along with current and previous day counts, 15-minute counts are stored for the last 8 hours. Threshold crossing alerts (TCAs) can be defined for each of these counts and used to detect degraded signal conditions. This performance monitoring information can be retrieved by the OS or remote dial-up. TCAs are automatically passed to the OS over the TBOS or TL1/X.25 telemetry link.

Fault isolation can be performed manually by determining which sites have reported LOS, AIS, or circuit pack failure. For example, if an OC-12 Regenerator detects LOS or AIS, but no upstream circuit pack failures are reported, the failure is likely caused by a cable cut.

Regenerator circuit packs cannot be individually looped back on themselves since they require a valid incoming OC-12 optical signal from the DDM-2000 OC-12 Multiplexer.

Optical span tests between DDM-2000 OC-12 Multiplexers and OC-12 Regenerators are done at the OC-12 Regenerator site by looping each optical span from the receiving OC-12 Regenerator in one direction to the transmitting OC-12 Regenerator in the other direction.

Order Wire

The DDM-2000 OC-3 and OC-12 Multiplexers use the E1 byte in the SONET overhead and provide a 64 kb/s complementary metal oxide semiconductor (CMOS) or transistor-transistor logic (TTL) compatible interface to an external order wire shelf to provide point-to-point voice communication between DDM-2000 systems.

The DDM-2000 OC-3 and OC-12 Multiplexers have been tested with the *DANTEL* * Order Wire Assembly A18-04588-02. See the appropriate "Miscellaneous Equipment and Tools" section for ordering details.

MegaStar 2000 Order Wire

The *MegaStar*-2000 radio system using a DDM-2000 OC-3 Multiplexer may provide access to either the SONET line overhead E1 byte, or multiplexed (MUX) bytes for SONET line order wire functions. The E1 order wire function supports a bi-directional 64 Kb/s complementary metal oxide semiconductor (CMOS) or, transistor-transistor logic (TTL) compatible interface to an external order wire shelf to provide point-to-point voice communication between DDM-2000 systems. This capability is available either with: Release 6.2 and BBG5 SYSCTL and BBG7 OHCTL, or with Releases 8.1 and 9.1 and BBG8/BBG8B SYSCTL and BBG10 OHCTL.

The MUX order wire function supports a bi-directional 1.544 Mb/s proprietary interface to a Harris-Farinon Mini-CSU. The 1.544 Mb/s data stream contains E1, E2 and F1 SONET line overhead byte information from both east and west SONET transmission directions.

* DANTEL is a registered trademark of Dantel, Inc.

Protection Switching

Line Protection Switching

Line protection switching occurs automatically in response to detected faults, as well as in response to external commands from technicians at a local or remote CIT or OS. The DDM-2000 OC-3 and OC-12 Multiplexers use SONET standard line protection switching and protection of all transmission and synchronization circuit packs. The protection circuit pack equipage is optional. The DDM-2000 OC-3 and OC-12 Multiplexers use standard protection switching priorities as follows:

- Inhibit automatic protection switch (APS)
- Lockout of protection
- Forced switch
- Automatic switch: signal fail
- Automatic switch: signal degrade
- Manual switch.

The DDM-2000 OC-3 and OC-12 Multiplexers use unidirectional 1+1 nonrevertive line switching. Automatic protection switch procedures as specified by the Phase 2 SONET standard are used.

Automatic line switches are initiated by signal fail and signal degrade conditions on the received OC-N signal. This signal's BER is calculated from violations in the SONET line overhead B2 parity byte. Signal fail is declared for incoming loss of signal, loss of frame, line AIS, or a BER exceeding 10^{-3}, while a BER exceeding a provisionable 10^{-5} to 10^{-9} threshold causes the signal degrade condition. A line protection switch will be completed within 60 milliseconds of the onset of a hard failure such as a fiber cut.

In multispan applications (for example, hubbing or add/drop), each OC-N span switches independently. For example, in OC-3 hubbing applications, a switch on the central office-to-hub span will not cause switches on any of the hub-to-remote spans. Similarly, a line switch on a hub-to-remote span will not propagate to other hub-to-remote or central office-to-hub spans.

MegaStar 2000 Protection Switching, Linear Configuration

The *MegaStar* 2000 radio system using the DDM-2000 OC-3 Multiplexer utilizes a modified linear automatic protection scheme (APS). In a standard linear SONET configuration utilizing a 1+1 protection scheme, one OC-N is designated as

working and the other as protection. The status of these two optical lines is conveyed via information contained in the K1 and K2 bytes, and is used to light LEDs on the corresponding working OLIU circuit pack.

In the *MegaStar* 2000 APS, the radio sub-system does not terminate the SONET overhead and does not access the K1 or K2 bytes. Instead, the *MegaStar* 2000 APS scheme utilizes the miscellaneous discrete inputs of the DDM-2000 OC-3 Multiplexer with an auxiliary connection to the radio sub-system. Also, the radio sub-system transmits either the working or protection line, not both. This configuration is detailed in Figure 5-6.

The radio sub-system reports via miscellaneous discretes which IS-3 it is using to transmit via the radio link. The DDM-2000 then uses the information from its miscellaneous discrete input to light the appropriate LED on the working OLIU. Information from the miscellaneous discretes is not needed in the receive IS-3 direction since the DDM-2000 will select one of two OLIUs to be working in the receive direction.

MegaStar 2000 ring configurations do no follow this protection scheme since rings do not use 1+1 protection. Therefore, *MegaStar* 2000 ring configurations employ path protection switching identical to optical rings.

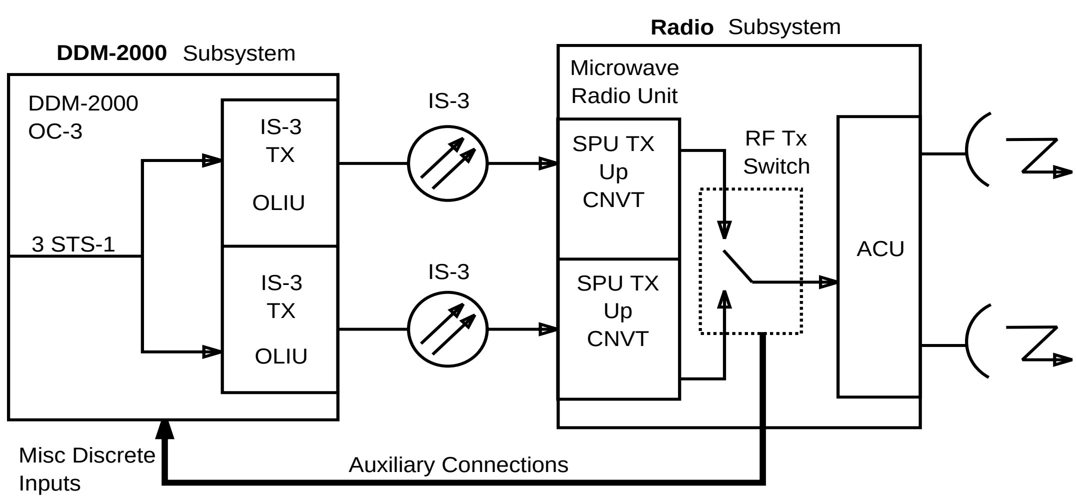

Figure 5-6. MegaStar 2000 Interconnections, DDM-2000 to Radio Subsystem

Path Protection Switching (Path Switched Rings)

The DDM-2000 OC-3 and OC-12 Multiplexers support path switched ring applications using the path protection switching schemes described in Telcordia Technologies TR-TSY-000496. This scheme offers 60-millisecond restoration times and simple network administration for access applications. The ring facility consists of two fibers, with service and protection rotating in opposite directions. Each low-speed input is duplicated and transmitted in both directions around the ring. The receiving end terminal monitors the quality of both signals and selects the best signal to drop to its low-speed interface. Path selection occurs on the VT1.5 level for DS1 services or the STS-1 path level for DS3 and EC-1 services.

Path protection switching is nonrevertive. A manual path protection switching command allows switching back to the original path for ease of ring maintenance. Path switching is triggered by incoming LOS, AIS, STS unequipped or STS-1 path BER exceeding 10^{-3}. Certain OLIUs also support path protection switching based on VT unequipped and STS/VT signal degrade criteria (see Table 4-3 in the “Product Description” section of this manual). Technician control of path protection is provided with standard lockout, forced switch, and manual switch commands.

The DDM-2000 OC-12 Multiplexer provides a "0x1" of STS-1 paths dropped from an OC-12 path switched ring for interworking with a DDM-2000 OC-3 Multiplexer. This configuration provides an OC-12 VT1.5 path switched ring. In a "0x1" configuration, the DDM-2000 OC-12 Multiplexer does not perform switching on the STS-1 signals sent to the DDM-2000 OC-3 Multiplexer. Rather, it feeds the two STS-1 signals (one from each ring direction) directly to the DDM-2000 OC-3 Multiplexer, allowing it to perform path switching. See Section 4, "Product Description" for more information on ring (0x1) and linear (1+1) interfaces.

Dual Ring Interworking (DRI)

The DDM-2000 OC-3 and OC-12 Multiplexers support dual ring interworking (DRI) which provides end-to-end protection from loss of service on traffic traveling over interconnected rings. This is achieved by connecting the two rings at two dual-homing offices and by provisioning the multiplexers at these nodes to "drop and continue" all necessary paths. This provides a redundant path in case of a catastrophic failure at one of the two DRI offices or one of the nodes in each DRI office. The end nodes perform standard path protection switching on the signals from these two redundant paths.

Equipment Protection

The timing generator circuit packs and transmission circuit packs are 1x1 protected and use nonrevertive switching except for the DS1 circuit packs. The ACTIVE LEDs on the 1x1 protected circuit pack faceplates show which circuit packs are carrying service. This aids technicians in circuit pack replacement procedures.

The DS1 circuit packs in the DDM-2000 OC-3 Multiplexer are 1x7 protected and use revertive switching.

SLC 96 Carrier Protection Switching

This feature translates an incoming DS1 bipolar violation alarm into an outgoing DS1 loss of signal (all zeros). The *SLC* carrier system central office terminal will detect this loss of signal and initiate protection switching of the DS1. This feature allows the standard *SLC* 96 carrier system protection scheme to work through the fiber transports provided by the DDM-2000 terminals without the use of subscriber loop interface module (SLIM) terminals.

Performance Monitoring

Performance Monitoring Parameters

The DDM-2000 OC-3 and OC-12 Multiplexers use performance monitoring (PM) to support proactive maintenance of the network and tariffed service performance verification. Proactive maintenance refers to the process of detecting degrading conditions not severe enough to initiate protection switching or alarming but indicative of an impending hard or soft failure. Hard and soft failures result in reactive maintenance.

Proactive maintenance consists of monitoring performance parameters associated with the SONET sections, lines, and paths within the SONET network. Table 5-1 lists the SONET performance parameters monitored by DDM-2000. These parameters are thresholded to indicate degraded performance. When a performance-monitoring threshold is crossed, it is reported to the message-based operations system where all threshold crossings associated with a particular path can be correlated, and the likely source of the degradation can be identified.

Figure 5-7 shows DS1/DS3 line and path and DS3 path performance monitoring. The DDM-2000 OC-12 Multiplexer monitors DS3 line and path parameters from the DSX-3 and DS3 path parameters from the optical path.

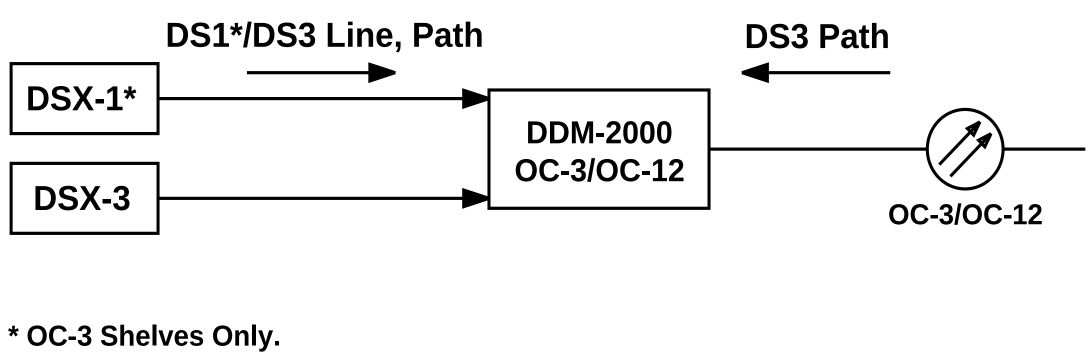

Figure 5-7. DS1/DS3 Line and Path and DS3 Path Performance Monitoring

The following are definitions and explanations for the terms used in the figure:

- Line — A line is a physical transport vehicle that provides the means of moving digital information between two points in a network. The line is characterized by a metallic transmission medium and its specific coding type. A line is bounded by its two end points, known as line terminations. A line termination is the point where the electrical, bipolar line signal is generated and transmitted, or received and decoded.
  - DS1 — In DDM-2000 OC-3 Release 7.2, and later releases, DS1 line for alternate mark inversion (AMI) or bipolar 8-zero substitution (B8ZS) coding is monitored and the errored second (ES-L) data is displayed for the incoming signal from the DSX-1.
  - DS3 — In DDM-2000 OC-3 Release 7.2, OC-12 Release 5.0, and later releases, DS3 line for bipolar 3-zero substitution (B3ZS) coding is monitored and the data is displayed in CV-L, ES-L, and SES-L registers for the incoming signal from the DSX-3.
- Path — A path is a framed digital stream between two points in a network and represents digital signal transport at a specified rate, independent of the equipment and media providing the physical means of transporting the signal. A path is defined by its two end points, called path terminations, where its frame structure is generated and decoded. A path may be carried wholly within one transport segment (line), or it may span a sequential arrangement of two or more transport segments.
  - DS1 — In DDM-2000 OC-3 Release 5.1 and later releases, DS1 near-end path is monitored for SF framing and both near-end and far-end paths are monitored for ESF framing. The data is displayed in ES-P, SES-P, and UAS-P categories. In Release 7.2 and later releases, CV-P is also displayed.
  - DS3 — In DDM-2000 OC-3 Release 7.1, OC-12 Release 3.1, and later releases, DS3 path incoming from the fiber (high-speed side) is monitored for both P-bits and F&M bits and the data is displayed in CV-P, ES-P, SES-P, and UAS-P registers. In addition, severely errored frame second (SEFS) is also monitored and displayed.

In DDM-2000 OC-3 Release 7.2, OC-12 Release 5.0, and later releases, DS3 path incoming from the DSX-3 (low speed side) is also monitored, in addition to monitoring the path from the fiber, for both P-bits and F&M bits. The same registers are also displayed for the data from the DSX-3.

In DDM-2000 OC-3 Releases 8.0 and 9.0, OC-12 Release 5.0, and later releases, DS3 path from both the fiber and the DSX-3 are monitored for C-Bits and are displayed in the same registers as previously. The far-end data (FEBE bits) is monitored and displayed as well.

DS1 Performance Monitoring

Tariffed service verification consists of monitoring performance parameters that can be associated with the customer's end-to-end service. The DDM-2000 OC-3 system provides this capability for DS1 services with the DS1 performance monitoring feature. Based on *ANSI** T1.403 extended superframe format (ESF), this capability retrieves performance report messages written into the ESF data link by the customer's terminal equipment. From these messages, the DDM-2000 can determine and report the end-to-end error performance of the entire DS1 link *as seen by the customer*. These parameters, listed in Table 5-1, are thresholded and reported to indicate degraded performance, and the counts are retrieved by the message-based operations system to determine if the service is operating within tariffed limits.

Table 5-1 list the combined performance monitoring parameters for both DDM-2000 OC-3 and DDM-2000 OC-12 Multiplexers. Some parameters are release specific. See the respective user/service manual for specific parameters and details.

* Registered trademark of American National Standards Institute.

Table 5-1. Performance Monitoring Parameters

Facility	Measured Parameter	OC-3	OC-12
OC-3 Optics	Laser Bias Current *	Yes	Yes
	Laser Transmit Power *	Yes	Yes
OC-12 Optics	Laser Bias Current †	NA	Yes
OC-1 Section	SE Frame Seconds (SEFS)	Yes	NA
OC-3 Section	Severely Errored Frame Seconds (SEFS)	Yes	Yes
OC-12 Section	Severely Errored Frame Seconds (SEFS)	R11	Yes
OC-1 Line	B2 Coding Violations (CV)	Yes	NA
	B2 Errored Seconds (ES)	Yes	NA
	B2 Errored Seconds Type A (ESA)	Yes	NA
	B2 Errored Seconds Type B (ESB)	Yes	NA
	B2 Severely Errored Seconds (SES)	Yes	NA
	B2 Unavailable Seconds (UAS)	Yes	NA
EC-1 Line	B2 Coding Violations (CV)	Yes	R2.1
	B2 Errored Seconds (ES)	Yes	R2.1
	B2 Errored Seconds Type A (ESA)	Yes	R2.1
	B2 Errored Seconds Type B (ESB)	Yes	R2.1
	B2 Severely Errored Seconds (SES)	Yes	R2.1
	B2 Unavailable Seconds (UAS)	Yes	R2.1
	STS Pointer Justification Counts	R11	R7.0
OC-3 Line	B2 Coding Violations (CV)	Yes	Yes
	B2 Errored Seconds (ES)	Yes	Yes
	B2 Errored Seconds Type A (ESA)	Yes	Yes
	B2 Errored Seconds Type B (ESB)	Yes	Yes
	B2 Severely Errored Seconds (SES)	Yes	Yes
	B2 Unavailable Seconds (UAS)	Yes	Yes
	Line Protection Switch Counts (PSC-L)	Yes	Yes
	STS Pointer Justification Counts	R11	R7.0
OC-12 Line	B2 Coding Violations (CV)	R11	Yes
	B2 Errored Seconds (ES)	R11	Yes
	B2 Errored Seconds Type A (ESA)	R11	Yes
	B2 Errored Seconds Type B (ESB)	R11	Yes
	B2 Severely Errored Seconds (SES)	R11	Yes
	B2 Unavailable Seconds (UAS)	R11	Yes
	Line Protection Switch Counts (PSC-L)	R11	Yes
	STS Pointer Justification Counts	R11	R7.0
STS-1 Path	B2 Coding Violations (CV)	Yes	Yes
	B2 Errored Seconds (ES)	Yes	Yes
	B2 Errored Seconds Type A (ESA)	Yes	Yes
	B2 Errored Seconds Type B (ESB)	Yes	Yes
	B2 Severely Errored Seconds (SES)	Yes	Yes
	B2 Unavailable Seconds (UAS)	Yes	Yes

Facility	Measured Parameter	OC-3	OC-12
VT1.5 Path	V5 Errored Seconds (ES) V5 Severely Errored Seconds (SES) V5 Unavailable Seconds (UAS)	Yes Yes Yes	NA NA NA
DS3 Path	P-bit Coding Violations Severely Errored Frame Seconds (SEFS)	Yes Yes	Yes Yes
Enhanced DS3 Path for both P-bit and F&M Bits (From Fiber Only)	CV-P Coding Violations Severely Errored Frame Seconds (SEFS) ES-P Errored Seconds SES-P Severely Errored Seconds UAS-P Unavailable Seconds	R7.1 and later	R3.1 and later
Enhanced DS3 Path for P-bit, F&M BIts, and C-bit (From Fiber and DSX)	CV-P Coding Violations Severely Errored Frame Seconds (SEFS) ES-P Errored Seconds SES-P Severely Errored Seconds UAS-P Unavailable Seconds	R7.2 ‡ (BBG4B) and later	R5.0 (BBG11B) and later
DS3 Line	Line Coding Violations (CVL) Errored Seconds (SESL) Severely Errored Seconds (SESL)	R7.2 (BBG4B) and later	R5.0 (BBG11B) and later
DS1 Path	Errored Seconds, Path (ESP) Errored Seconds, Path Far-end (ESPFE) Severely Errored Seconds, Path (SESP) Severely Errored Seconds, Path Far-end (SESPFE) Unavailable Seconds, Path (UASP) Unavailable Seconds, Path Far-end (UASPFE)	Yes § Yes § Yes § Yes § Yes § Yes §	NA NA NA NA NA NA
Enhanced DS1 Path	Coding Violations, Path (CVP) Coding Violations, Path Far-end (CVPFE)	R7.2 § and later	NA
DS1 Line	Errored Seconds, Line (ESL)	R7.2 § and later.	NA
	Enhanced Line Signal Threshold (BERL)	R8.0 and later.	NA

* 21G-U OLIU only.

† 23G/23G-U and 23H-U OLIUs only.

‡ C-Bit with Release 8.0 and later releases.

§ Current and previous day parameters only. Release 9.1 and later supports the current 15-minute and the previous 32 quarter-hour bins.

Application of the OC-3 DS1 performance monitoring feature for tariffed service verification is shown in Figure 5-8. Figure 5-8 shows an *ANSI* T1.403 ESF format DS1 service carried between points A and Z, using an OC-3 system and terminated at the customer's premises with channel service units (CSUs). At the "A" end, the received error performance (Z - A) is detected and written by the customer's CSU onto the outgoing (A - Z) ESF data link as a performance report message (PRM). The DS1PM circuit pack interfacing the A end reads the incoming DS1 signal's PRM (received from the customer's premises) and reports the Z - A performance. Likewise, the OC-3 system interfacing the Z end reports the A - Z performance by reading the PRM from the customer's "Z" CSU. By reviewing the data from each OC-3 system, the service provider can determine the complete end-end performance (A - Z and Z - A) of the customer's service.

Additionally, each DS1PM circuit pack measures the near-end performance of the incoming DS1, allowing the service provider to determine if a good DS1 signal was received from the customer before transporting it through the network. This information can then aid in sectionalizing any reported performance problems. The DS1PM circuit pack can also provide this same near-end information for super frame (SF) formatted (sometimes known as "D4 framing") DS1 services, but complete end-to-end performance verification is limited due to the lack of the PRM in the SF format.

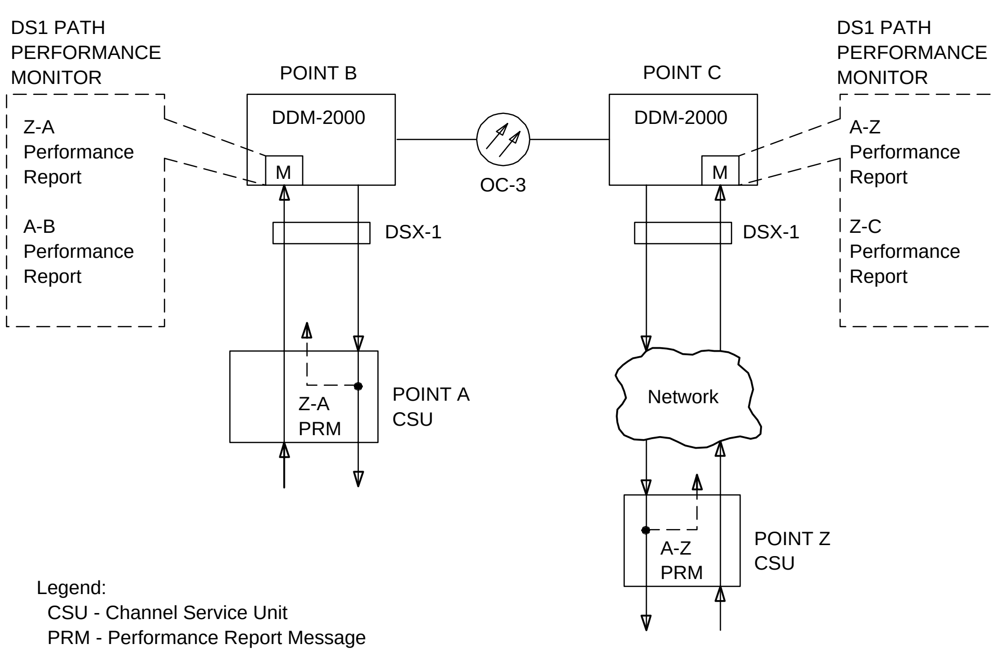

Figure 5-8. DDM-2000 DS1 Path Performance Monitoring

The DDM-2000 OC-3 Multiplexer Release 8.0 (linear) and Release 7.2 and 9.0 (rings) provide the following DS1 enhancements:

- DS1 Line
  - Reporting line errored seconds (ESL) on the incoming DS1 bipolar/ B8ZS violations from the DSX-1.
  - In Release 9.0 (rings) and later releases, adding provisionable bit error ratios (BERL) of 10^{-7} and 10^{-8} in addition to 10^{-3} and 10^{-6} for DS1 lines. Threshold crossing alerts are provided for these new BERLs.
- DS1 Path
  - Including CVP and CVP (FE) daily counts in the DS1 path PM report.
  - In Release 9.1 and later, all DS1 PM parameters will be reported in quarter-hour bins, in addition to daily bins.

DS3 Performance Monitoring

Enhanced DS3 Performance Monitoring

DDM-2000 OC-3 Release 7.1 and DDM-2000 OC-12 Release 3.1 and later releases provide two DS3 path PM options: enhanced P-bit (parity bit) and adjusted F&M bit (frame and multiframe bit). The options are selected using a command that also sets the PM mode to "on" (default) or "off," which enables or disables the monitoring and reporting of DS3 path PM data. SeeTable 5-1.

Enhanced P-Bit

When provisioned for enhanced P-bit, the system calculates and provides counts of DS3 P-bit coding violations (CV), errored seconds (ES), severely errored seconds (SES), and unavailable seconds (UAS) incoming from the fiber. Quarter-hour and current day registers are provided with provisionable threshold crossing alerts (TCAs) on a per shelf basis. Severely errored frame seconds (SEFS) are also monitored.

Because P-bits can be corrected at nodes provisioned for VMR along a DS3 path, the DS3 P-bit PM data may not provide a complete report of the end-to-end DS3 path errors.

Adjusted F&M Bit

Adjusted F&M bit performance monitoring provides an alternative method for determining and accumulating DS3 path performance data based on an error estimation technique using errors on the F&M framing bits to approximate the actual error counts in the DS3 path payload. F&M bits are not corrected at nodes provisioned for VMR along a DS3 path. When provisioned for adjusted F&M bit, the system calculates and provides estimated counts of DS3 adjusted F&M bit

coding violations (CV), errored seconds (ES), severely errored seconds (SES), and unavailable seconds (UAS) incoming from the fiber.

Quarter-hour and current day registers are provided with provisionable threshold crossing alerts (TCAs) on a per shelf basis. Severely errored frame seconds (SEFS) are also monitored.

The DDM-2000 OC-3 Multiplexer, Release 8.0 (linear) and Release 7.2 and 9.0 (rings) and later releases, and the DDM-2000 OC-12 Multiplexer, Release 5.0 (rings), feature enhanced DS3 performance monitoring using the new BBG4B and BBG11B circuit packs, respectively. These enhancements are:

- DS3 P-Bit and adjusted F&M bit PM from the DSX-3.
  - Incoming CV, ES, SES, UAS, and SEFS from the DSX, in addition to the same data from the fiber, are calculated and reported.
- DS3 Line
  - Monitoring and reporting of CVL, ESL, and SESL on incoming DS3 B3ZS data from the DSX3.
  - Adding provisionable bit error ratios (BERL) of 10^{-7}, 10^{-8} and 10^{-9} in addition to 10^{-3} and 10^{-6} for DS3 lines. Threshold crossing alerts are provided for these new BERL ratios.

C-Bit

DDM-2000 OC-3 Release 8.0 (linear), Release 9.0 (rings) and later releases and OC-12 Release 5.0 and later releases provide DS3 path performance monitoring using the C-bit option. When the C-bit option is selected, both near-end and far-end (far-end block errors) performance monitoring data are monitored and displayed.

The system provides counts of DS3 C-bit parity coding violations (CV-P), errored seconds (ES-P), severely errored seconds (SES-P), and unavailable seconds (UAS-P) incoming from both the DSX-3 and the fiber. The type of performance monitoring is provisioned per DS3 service by a CIT command.

For C-bit performance monitoring, the DS3 service can be provisioned in violation monitor (VM) or violation monitor and removal (VMR) modes. In VMR mode, the C-bit errors are not corrected as in the P-bit option.

Quarter-hour and day registers are provided with provisionable threshold crossing alerts (TCAs). The TCAs are provisionable on a per shelf basis. Severely errored frame seconds (SEFS) counts are also provided.

Performance Monitoring Data Storage

The DDM-2000 OC-3 and OC-12 Multiplexers provide current quarter-hour and current day registers for all accumulated performance parameters. The previous 8 hours of quarter-hour and previous day registers are also provided.

The DDM-2000 OC-3 and OC-12 Multiplexers can initialize these registers through the CIT locally or remotely at any time, as well as retrieve and report their contents.

Performance Parameter Thresholds

The current quarter-hour and current day thresholds for each parameter type are provisionable, using the CIT, on a per shelf basis. If values other than the defaults are used, only one value for each parameter type needs to be set. Whenever the current quarter-hour or the current day threshold for a given parameter is exceeded, the DDM-2000 OC-3 and OC-12 Multiplexers generate a threshold-crossing alert (TCA) that is entered into the performance monitoring exception report and reported to the OS.

TCA Transmission to OS

The TCA information may be reported to the OS, using serial telemetry or the TL1/X.25 message-based OS interface. TCAs can be used to trigger proactive maintenance activity at the OS.

Each alarm, status, and control (AS&C) TBOS display contains a summary performance-monitoring TCA point. This performance summary point shows a threshold crossing for any monitored parameter in the current quarter-hour or day.

The TL1/X.25 OS interface should be used to derive full benefit from the DDM-2000 OC-3 and OC-12 Multiplexers' performance-monitoring capabilities. The full set of performance monitoring data stored by the DDM-2000 OC-3 and OC-12 Multiplexers (TCAs and the contents of PM registers) is provided through the TL1/X.25 interface.

Provisioning

General

The DDM-2000 OC-3 and OC-12 Multiplexers allow the user to customize many system characteristics through provisioning features. Provisioning parameters are set by a combination of on-board switches and software control.

Only those system parameters fixed at installation time (for example, DS1 and DS3 line buildouts) are set with on-board switches. Some parameters needed for typical installations, such as line coding, that may need to change later are settable by switches and overridable by software. This allows typical installations to be performed without a CIT. Other parameters that require a wide range of options or in-service changes must be set under software control. For example, performance monitoring thresholds and VT1.5, STS-1, or STS-3c cross-connections can be customized for each installation using the CIT interface.

Default Provisioning

Installation provisioning is minimized with thoughtfully chosen default values set in the factory. Every parameter has a factory default value. These factory defaults for software parameters are maintained in the SYSCTL circuit pack, and a single CIT command is provided to restore all default values. All provisioning data is stored in nonvolatile memory to prevent data loss during power failures and maintenance operations.

Remote Provisioning

Software control allows remote provisioning of DDM-2000 OC-3 and OC-12 Multiplexers. This feature is provided especially for provisioning parameters likely to change in service, in support of centralized operations practices.

Cross-Connection Provisioning

DDM-2000 OC-3 and OC-12 Multiplexers have time slot interchange (TSI) features. This offers users flexibility in directing traffic in and out of these systems to support a wide variety and range of customer applications.

Cross-connections in DDM-2000 OC-3 and OC-12 Multiplexers are made by specifying the SONET rate (VT1.5, STS-1, STS-3c), the end point addresses (access identifiers), the cross-connection type (two way, drop and continue, etc.) and, in some cases, the ring direction (ring=m1, ring=mb2, etc.). In DDM-2000 OC-3 and OC-12 Multiplexers, each single cross-connection command establishes a two way cross-connection.

Automatic Provisioning on Circuit Pack Replacement

Replacement of a failed circuit pack is simplified by automatic provisioning of the original circuit pack values. The SYSCTL circuit pack maintains a provisioning map of the entire shelf, so when a transmission or synchronization pack is replaced, the SYSCTL circuit pack automatically downloads the correct values to the new circuit pack. Likewise, if the SYSCTL circuit pack is ever replaced, the correct provisioning data from every other circuit pack in the shelf is automatically uploaded to the new SYSCTL circuit pack's nonvolatile memory.

Port State Provisioning

Port state provisioning is a feature provided on DDM-2000 OC-3 and OC-12 Multiplexers that suppresses alarm reporting and performance monitoring by supporting multiple states (automatic, in-service, and not-monitored) for DS1, DS3, EC-1, and LAN ports.

Ports without signals (undriven) are in the automatic state until changed to the in-service state when a signal is present. Commands allow a user to retrieve and change the state of a port to the not monitored state or from the not monitored state to the automatic state.

Channel State Provisioning

Automatic channel state provisioning is a capability provided on DDM-2000 OC-3 and OC-12 Multiplexers that suppresses reporting of transient alarms and events during provisioning by supporting multiple states (automatic, in-service, and not-monitored) for VT1.5, STS-1 and STS-3c channels.

While an end-to-end circuit is being set up, particularly during VT1.5, STS-1, or STS-3c cross-connect provisioning, several transient maintenance signals result. Without automatic channel state provisioning, these are reported as alarms and events. The technicians are expected to ignore these transient alarms and initiate corrective action only if the alarms persist after the provisioning is completed. To avoid the confusion created by this, DDM-2000 Multiplexers provide automatic channel state provisioning.

A VT1.5, STS-1, or STS-3c channel is kept in the default automatic (AUTO) state until the reception of valid signal (a framed non-AIS or non-LOP signal) in that channel. While in AUTO state, no alarms or events are reported on the channel by the DDM-2000 Multiplexer. On receiving a valid signal, which occurs when the end-to-end circuit is completely provisioned, the channel automatically changes to the in-service (IS) state, where it resumes normal alarm and event reporting. An additional state, not- monitored (NMON), is also supported in which alarm and event reporting is suppressed regardless of the validity of the signal being received on the channel. Like the port state provisioning capability already

provided for physical ports like DS1, DS3, and EC-1, the user can use CIT commands to manually change a channel from IS or AUTO to NMON, and from NMON to AUTO. A direct change from NMON to IS is not allowed.

Line State Provisioning

Beginning with OC-12 Release 2.3 (linear) and Release 5.0 (ring), the state of OC-3 interfaces can be controlled manually and set to NMON or IS. For OC-3 Release 9.0 and later ring releases, OC-1 interfaces can be set manually to NMON or IS.

AIS or Unequipped Provisioning

In DDM-2000 OC-3 releases prior to Release 8.0, if a DS1, DS3, or MXRVO circuit pack, or cross-connection was inadvertently removed, the system sent a "path AIS" signal. Beginning with OC-3 Release 8.0 and OC-12 Release 5.0, the DDM-2000 OC-3 and OC-12 shelf can be optioned to send an "STS/VT-path unequipped" signal instead.

MegaStar 2000 SONET Subsystem Provisioning

The SONET subsystem functions of the *MegaStar* 2000 radio system (using the DDM-2000 OC-3 Multiplexer Releases 8.1 or 9.1) must be provisioned to obtain the following features unique to *MegaStar* 2000: Order wire mode (E1 or MUX), and Radio interface (linear only).

Order wire provisioning may be done with one of two order wire drop modes (E1 or MUX). E1 order wire mode is a 64 Kb/s data channel capable of supporting point-to-point voice communications to a *DANTEL*[*] Order wire Assembly A18-04588-02 only. MUX order wire mode provides access to the E1, E2 and F1 SONET overhead bytes in a proprietary 1.544 Mb/s data stream for use with the Harris-Farinon mini-CSU equipment.

Radio interface provisioning is necessary to inhibit K-byte messaging used in automatic protection switching. The DDM-2000 Multiplexer uses the K1 and K2 bytes for APS in a linear configuration. These K-bytes designate a working and protection line for the 1+1 linear transport scheme. The Radio Subsystem takes either the working or protection line and transmits this across the radio link. Therefore, the DDM-2000 APS scheme must be disabled for those OC-3 links (IS-3) that are intended to be carried by radio. Auxiliary connections between the Radio Subsystem and the DDM’s miscellaneous discretes let the DDM-2000 know which OC-3 is being transmitted by the Radio Subsystem, and in turn light the corresponding LED on the working OLIU.

* DANTEL is a registered trademark of Dantel, Inc.

Reports

Alarms and Statuses

The system provides an alarm report that lists all active alarm and status conditions. A description of the condition (for example, controller failure, incoming high-speed signal failure, synchronization hardware or reference failure, etc.) is included in the report along with a time stamp indicating when the condition was detected, its severity, and whether it is service affecting or not. The option to display specified subsets of alarm conditions is provided (for example, critical alarms only).

Status conditions include:

- Manually initiated abnormal conditions (for example, manual protection switching, manual lockouts, loopbacks, system testing)
- Automatic protection switching status (equipment and line switching)
- Incoming AIS detected
- Incoming FERF detected
- ACO active.

A description of the status condition (for example, DS1 loopback active, DS1 protection switch active, etc.) is included in the report along with a time stamp indicating when the condition began.

Performance Monitoring

TCA Summary Report

The system provides a report that lists the number of performance-monitoring parameters that have crossed their thresholds. This report provides a snapshot of the system performance level. If there is a signal degradation, it is quickly pinpointed so that corrective action may be taken before customers are affected thus supporting proactive maintenance.

This report provides separate parameter summaries for each signal level in the system (optics, section, line, and path). The parameter summaries show the user which performance status reports to request if they want further information.

Performance Status Reports

These reports provide a detailed profile of the current and previous 8 hours in quarter-hour (15-minute) increments, as well as the current and previous day's

performance. Threshold-crossing alerts are clearly identified and the time the performance registers were last initialized is also shown. Any registers that may have been affected by this initialization are marked. There are separate reports for optics plus section, line, and path parameters.

Maintenance History

A maintenance history report containing the past alarm, status, protection switching, and CIT (for example, provisioning, loopback request, manual protection, etc.) events is provided. This summary contains time stamps indicating when each condition was detected and when it cleared. CIT events contain a time stamp indicating when the command was entered. See the appropriate OC-3 or OC-12 user/service manual for details on the history log.

States

The state report shows the state of all circuit packs installed in the system, either equipped or auto and the state of the individual low-speed channels as not monitored (NMON), in service (IS), or auto on DS1 and DS3 interface packs. Auto refers to a slot that is available for automatic provisioning. For low-speed channels, the auto state would transition to the IS state if a good signal is detected.

Provisioning

The provisioning report contains the current values of all electronically provisionable parameters and switch-selectable parameters.

Version/Equipment List

The DDM-2000 OC-3 and OC-12 Multiplexers provide a full inventory report on all hardware and software installed in local and remote systems. The following information is provided:

- Circuit pack name
- 10-character *CLEI*[*] code
- 6-digit equipment catalog item (ECI)
- 10-character apparatus code

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* COMMON LANGUAGE is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Bell Communications Research, Inc.

- 6-character series number
- 12-character serial number (includes date and location of manufacture)
- 6-digit program version (software generic) code
- 5-character program identification (PID) code for replaceable EPROMs.

Administration

Software Upgrades

The DDM-2000 OC-3 and OC-12 Multiplexers provide an in-service software installation capability to update the generic program in local and remote systems. Upgrades are distributed on *MS-DOS* formatted diskettes containing the new software and an installation program. These software upgrades are the primary mechanism to add new feature enhancements to the in-service DDM-2000 network. All software upgrades are "in-service" and do not affect any provisionable parameters. For example, cross-connections are left unchanged by the software upgrade.

The procedure is straightforward. The technician connects an *MS-DOS* personal computer (PC) serial port to the CIT port on the local DDM-2000 Multiplexer, starts the installation program, and is prompted with a few safety questions before the upgrade installation actually begins. After the technician confirms to proceed, the PC or ITM SNC takes over the process and completes the installation.

In OC-3 Release 9.1, OC-12 Release 5.1 and later releases, software download takes place in two stages: In the first stage, software is copied to each DDM-2000 NE in the subnetwork. In the second stage, a command is issued which causes the software to be installed. This enables the user to distribute a new release throughout the subnetwork while the old release continues to run. The new software is installed throughout the subnetwork over the DCC without having to dispatch technicians to each remote site. When finished, the DDM-2000 Multiplexer automatically restarts with the new software. See “Software Download and Copy” in this section for more release specific information.

Subnetwork Size

Table 5-2 and Table 5-3 list the maximum number of DDM-2000 and FT-2000 OC-48 Lightwave System network elements (NEs) that each software release can support in a single subnetwork. Each NE counts as one. Larger networks may be supported for particular applications or with new software releases should subnetwork growth be a concern. Also, there is no limitation on the size of the networks formed by splitting a large network into a number of smaller maintenance subnetworks by disabling the DCC between the subnetworks. Software upgrades and DCC partitioning can be done in service without affecting traffic. In DDM-2000 OC-3 R13.0, R15.0, and OC-12 R7.0 subnetwork sizes of up to 256 NEs are supported via subnetwork partitioning with multiple areas connected via Level 2 Intermediate Systems (IS).

Table 5-2. OC-3 Multiplexer — Maximum Number of NEs in a Subnetwork

	Linear						
Releases	3.2	6.2	8.0	8.1			
Number of NEs *	8	10	32	32			
	Ring						
Releases	7.1	7.2	9.0	9.1	11.x	13.0	15.0
Number of NEs *	16	24	32	50	50	50/256†	50/256†

* 24 NEs in subnetworks with FT-2000 OC-48 R6.0.n, 32 with R7.x. In mixed networks, the lowest number of NEs supported (as determined by software release) determines the maximum number.

† 50 per Level 1 area and 256 per subnetwork, including FT-2000 OC-48 R9.1, also. See 824-102-144, *Lucent Technologies 2000 Product Family, Multi-Vendor Operations Interworking Guide*.

Table 5-3. OC-12 Multiplexer — Maximum Number of NEs in a Subnetwork

	Linear						Ring					
Releases	1.1	1.2	2.0	2.1	2.2	2.3	3.0	3.1	5.0	5.1	5.2	7.0
Number of NEs *	10	10	10	10	10	10	10	16	32	50	50	50/256†

* 24 NEs in subnetworks with FT-2000 OC-48 R6.0.n, 32 with R7.x. In mixed networks, the lowest number of NEs supported (as determined by software release) determines the maximum number.

† 50 per Level 1 area and 256 per subnetwork, including FT-2000 OC-48 R9.1, also. See 824-102-144, *Lucent Technologies 2000 Product Family, Multi-Vendor Operations Interworking Guide*.

The *SLC*-2000 uses the DDM-2000 OC-3 Multiplexer software along with a *SLC*-2000 specific DLC software package. If there are *SLC*-2000s in the subnetwork that are to be upgraded, care must be taken to make sure the DLC software is compatible with the DDM-2000 OC-3 software. The DLC software may need to be upgraded also. The *SLC*-2000 upgrade package (for Release 3 and later) includes all the necessary software to upgrade both the *SLC*-2000 and the DDM-2000 systems. See 363-208-000, *SLC-2000 Access System, Applications, Planning, and Ordering Guide*, for more information.

Software Compatibility

Table 5-4 lists the SONET software compatibility within a subnetwork for the Lucent 2000 Product Family systems. All configurations listed support Operations Interworking (OI). The table lists all possible software combinations. Combinations not listed are not supported.

Table 5-4. OI Software Compatibility

	OC-3														OC-12						
Release	3.2	6.2	7.0	7.1	7.2	8.0	8.1	9.0	9.1	11.0	11.1	13.0	15.0	15.1	2.3	3.1	5.0	5.1	5.2	7.0	7.1
OC-3, R3.2	X																				
OC-3, R6.2		X		X											X						
OC-3, R7.1		X		X											X	X					
OC-3, R7.2					X	X	X	X	X	X	X						X	X	X		
OC-3, R8.0					X	X		X	X	X	X						X	X	X		
OC-3, R8.1					X		X	X	X	X	X						X	X	X		
OC-3, R9.0					X	X	X	X									X	X	X		
OC-3, R9.1					X	X	X		X								X	X	X		
OC-3, R11.0					X	X	X			X							X	X	X		
OC-3, R11.1					X	X	X				X						X	X	X		
OC-3, R13.0												X	X	X						X	X
OC-3, R15.0												X	X	X						X	X
TRCU3												X	X	X						X	X
OC-12, R2.3		X		X											X						
OC-12, R3.1				X												X					
OC-12, R5.0					X	X	X	X	X								X				
OC-12, R5.1					X	X	X	X	X	X	X							X			
OC-12, R5.2					X	X	X	X	X	X	X								X		
OC-12, R7.0												X	X	X						X	X
FiberReach, R2.1					X*	X*		X	X	X	X							X*	X*		
FiberReach, R2.2										X	X						X	X	X		
FiberReach, R3.0												X	X	X						X	X
FiberReach, R3.1												X	X	X						X	X
FiberReach, R4.0												X	X	X						X	X

Table 5-4. OI Software Compatibility

Release	OC-3														OC-12						
	3.2	6.2	7.0	7.1	7.2	8.0	8.1	9.0	9.1	11.0	11.1	13.0	15.0	15.1	2.3	3.1	5.0	5.1	5.2	7.0	7.1
SLC-2000, R1.0	X																				
SLC-2000, R2.0	X																				
SLC-2000, R3.0		X																			
SLC-2000, R3.2		X		X	X			X					X		X	X					
SLC-2000, R3.3					X	X	X	X	X	X	X	X	X				X	X	X	X	
SLC-2000, R4.2		X		X	X			X							X	X	X				
SLC-2000, R4.3					X	X	X	X									X				
SLC-2000, R4.4					X	X	X		X	X	X	X	X					X	X	X	
SLC-2000, R4.5											X	X	X								
SLC-2000, R4.6												X	X								
SLC-2000, R4.7													X								
FT-2000, R6.0 §					X	X	X	X	X	X	X						X	X			
FT-2000, R7.0					X	X	X	X	X	X	X						X	X	X		
FT-2000, R7.1 **					X	X	X	X	X	X	X						X	X	X		
FT-2000, R7.2 ††					X	X	X	X	X	X	X						X	X	X		
FT-2000, R8.1												X	X	X						X	X
FT-2000, R9.0												X	X	X						X	X
FT-2000, R9.1												X	X	X						X	X
CPro-2000 R3.0		X		X	X			X							X	X	X				
CPro-2000 R4.0					X	X		X									X				
CPro-2000 R5.0					X	X	X	X	X								X	X			
CPro-2000 R6.0		X			X	X	X	X	X	X							X	X			
CPro-2000 R6.1		X		X	X	X	X	X	X	X	X						X	X	X		
CPro-2000 R6.2		X		X	X	X	X	X	X	X	X						X	X	X		
CPro-2000 R7.0												X								X	
CPro-2000 R8.0												X								X	
CPro-2000 R9.0												X								X	
CPro-2000 R10.0												X	X							X	
ITM SNC R2.2		X		X	X	X		X	X						X	X	X	X	X		
ITM SNC R3.0		X		X	X	X	X	X	X						X	X	X	X	X		
ITM SNC R4.0		X		X	X	X	X	X	X	X					X	X	X	X	X		
ITM SNC R5.0		X		X	X	X	X	X	X	X		X			X	X	X	X		X	
ITM SNC R6.0		X		X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	
ITM SNC R8.0		X		X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	
ITM SNC R9.0		X	X	X	X		X			X	X	X			X	X		X	X	X	
ITM SNC R10.0		X	X	X	X		X			X	X	X	X		X	X		X	X	X	

* FiberReach requires an OC-3 Release 9.0 or later host.

† Supports EC-1 transmission dual ring interworking (DRI).

‡ Supports OC-3 transmission interfaces without DCC.

§ Supports OI with OC-3 DCC.

¶ Supports EC-1 transmission interfaces.

** Supports OI with OC-12 0x1 DCC and OC-12 1+1 transmission interface without DCC.

†† Supports OI with OC-12 1+1 DCC.

Database Backup and Restoral

The DDM-2000 databases can be backed up and restored from a file using CPro-2000 to protect valuable system information from loss due to a catastrophic failure. Catastrophic failures include:

- Shelf destruction by fire, hurricane, flood, or other natural event or intentional damage.
- Cabinet housing the shelf damaged by a vehicle.
- Manual errors during provisioning or maintenance.

The backup can be done using CPro-2000 through the CIT or TL1 port of any one of the DDM-2000s to all DDM-2000s in the subnetwork. The information that can be backed up and restored includes:

- Target identifier (TID)
- Software version
- System equipage
- Software readable hardware switch settings
- CIT provisionable parameters (controller circuit pack data and transmission circuit pack data with cross-connect map).

The database backup and restoral capability of CPro-2000 can be used to significantly simplify the installation of several shelves having similar or identical configurations. See 190-523-101 and /or 365-576-1xx, *CPro-2000 User Manual* for more information.

Security

The DDM-2000 OC-3 and OC-12 Multiplexers offer security against unauthorized access to CIT system functions. The use of security is provisionable for the front CIT port, the rear CIT (modem) port, and through the DCC. In addition to this, the DCC can be disabled, thus securely isolating that DDM-2000 system from possible remote intrusion. A provisionable timeout is available for each access port that enables automatic termination of inactive or unattended sessions.

There are four types of users:

- General users can select and maintain their own password.
- Three privileged user accounts are reserved for system security administration.
- Maintenance users are allowed to perform basic maintenance functions. These users can select and maintain their own passwords (OC-3 Release 8.1, 9.1 and later; OC-12 Release 5.1 and later).
- Reports only users can display certain system information but cannot change provisioning or maintenance parameters.

Beginning with OC-3 Release 8.0 and OC-12 Release 5.0, general and reports only users increased from 50 to 100. Lockout of nonprivileged users and log of all login attempts during lockout are provided.

6 System Planning and Engineering

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System Planning and Engineering

6

Overview

This section summarizes descriptive information used with applications information to plan procurement and deployment of the DDM-2000 OC-3 and OC-12 Multiplexers. There are a number of considerations that should be kept in mind when planning the DDM-2000 OC-3/OC-12 Multiplexers' role in the network. Projected customer requirements will determine initial capacity needed, as well as evolution to higher capacities. The advanced networking capabilities of the DDM-2000 OC-3/OC-12 Multiplexers can offer many economic and planning benefits, and certain guidelines should be followed to maximize these benefits. Physical installation considerations will be guided by the installation location (central office, uncontrolled, or customer locations). Initial network configuration will determine synchronization requirements. Synchronization should be planned on a network basis considering items like topology, reliability, internetwork connectivity, and service evolution.

DDM-2000 OC-3/OC-12 Shelf Capacity

The DDM-2000 OC-3 Multiplexer provides multiplexing and transport for up to 3 STS-1 signals in a terminal, add/drop, or ring configuration. In a terminal or ring configuration, this capacity may be utilized in any combination of low-speed inputs as follows:

- 84 DS1s
- 56 DS1s and 1 DS3 (or EC-1)
- 28 DS1s and 2 DS3s (or EC-1s)
- 3 DS3s (or EC-1s)
- 3 OC-3s
- 6 single-homed or 12 dual-homed OC-1 extensions or a mix with other services not to exceed the OC-3 shelf capacity.

In an add/drop configuration, this capacity may be utilized in any combination of low-speed inputs as follows:

- 56 DS1s
- 28 DS1s and 1 DS3 (or EC-1)
- 2 DS3s (or EC-1s)
- 2 OC-3s.

System growth proceeds in a modular fashion. Capacity can grow in increments of 4 DS1 signals, up to 28 DS1s per STS-1. The DDM-2000 OC-3 Multiplexer can also provide transport of a single STS-3c signal from one OC-3 interface to another.

In many instances, the OC-3 capacity may be sufficient for many years of growth. Should network needs grow beyond the OC-3 capacity, the facility can be upgraded while in service to the OC-12 capacity using the DDM-2000 OC-12 Multiplexer, or by replacing the OC-3 optics with OC-12 optics in the main slots of the OC-3 Multiplexer (ring only). The in-service capacity upgrade allows planners to position the network for increasing demands and future broadband services, without incurring high first costs due to unused capacity. The DDM-2000 OC-12 Multiplexer provides multiplexing and transport for up to 12 STS-1s, 4 STS-3cs, or a combination of STS-1s and STS-3cs up to a capacity equivalent of 12 STS-1s. For all OC-12 topologies, this capacity may be used in any combination of low-speed inputs as follows:

- 12 DS3s (or EC-1s)
- 1 OC-3 or OC-3c and 9 DS3s (or EC-1s)
- 2 OC-3s or OC-3c and 6 DS3s (or EC-1s)

- 3 OC-3s or OC-3c and 3 DS3s (or EC-1s)
- 4 OC-3s or OC-3c.

Each of the OC-3 interfaces can be replaced with an IS-3 interface (shelf interconnect operating at the 155 Mb/s rate) to a co-located DDM-2000 OC-3 Multiplexer. Alternatively, a DDM-2000 OC-3 Multiplexer can be equipped with OC-12 optics in the main slots to provide an OC-12 path-switched ring capable of dropping up to 3 or 7 STS-1 equivalent traffic. The remainder of the traffic, or up to 12 STS-1 or 4 STS-3c may be passed through. This OC-12 interface on the OC-3 Multiplexer supports all the applications including FiberReach supported by the OC-3 ring, thus providing cost efficient DS1 to OC-12 multiplexing.

DDM-2000 OC-3 and OC-12 Capacity and Topology Evolution

The first DDM-2000 product, the DDM-2000 OC-3 Multiplexer, initially supported traditional point-to-point applications at the synchronous optical network (SONET) OC-3 line rate. The DDM-2000 OC-3/OC-12 products now support upgrades to advanced topologies like add/drop linear networks, fiber hubs, OC-3c transport, and rings as well as capacity upgrades to the SONET OC-12 line rate and new capabilities such as EC-1 electrical multiplexer and OC-12 Regenerator applications. As the DDM-2000 OC-3/OC-12 products continue to evolve, upgrades to new topologies and capacities continue to be supported. These features of the DDM-2000 OC-3 and OC-12 Multiplexers enable them to cost effectively serve your needs now while protecting your advanced needs and networking features of tomorrow. Shelves can be added or deleted from any of the topologies: point-to-point, linear, hub, or ring in-service.

In-service upgrades are supported for adding or deleting a node from a DDM-2000 OC-3/OC-12 ring, and for upgrading an OC-3 ring to an OC-12 ring using the OC-12 Multiplexer or OC-12 optics in the OC-3 Multiplexer.

Table 6-1 shows the current DDM-2000 OC-3 and OC-12 Multiplexer topologies and upgrades, along with the software that supports them. Table 6-2 shows the same information for the current DDM-2000 OC-12 Multiplexer topologies and upgrades. The current products also support the upgrade from OC-3 point-to-point to OC-12 point-to-point or OC-12 hubbing and from OC-3 ring to OC-12 ring. As the DDM-2000 OC-3 and OC-12 Multiplexers continue to evolve, these tables will be updated to reflect the topology and capacity upgrades described as "future" in this document. Note that the ability to perform these upgrades in-service requires that the appropriate system resources be available as detailed throughout this chapter.

Table 6-1. Current DDM-2000 OC-3 Multiplexer Topology Upgrades (Note)

Software Release	Supported Topologies	Topology Upgrades Supported (In-Service)
2 (Linear)	point-point, STS-1 drop, OC-3 hub	point-point → STS-1 drop point-point → OC-3 hub STS-1 drop → OC-3 hub
3 (Linear)	point-point, STS-1 drop, OC-3 hub, STS-1 add/drop, DS1 add/drop	point-point → STS-1 drop point-point → STS-1 add/drop point-point → DS1 add/drop point-point → OC-3 hub STS-1 drop → STS-1 add/drop STS-1 drop → DS1 add/drop STS-1 drop → OC-3 hub STS-1 add/drop → DS1 add/drop
5 (Ring)	OC-3 VT1.5/STS-1 ring	point-point → ring
6 (Linear)	same as R3 plus — EC-1 interfaces	same as R3
7 (Ring)	same as R5 plus OC-3 optical extensions, VT1.5/STS-1 drop and continue	point-point → ring STS-1 drop → ring
8 (Linear)	same as R6	same as R6
8.1 (Linear)	same as R8 plus *MegaStar* support	same as R8
9 (Ring)	same as R7 plus OC-1 rings	same as R7
9.1 (Ring)	same as R9 plus additional OC-1 ring topologies	same as R9
11.0 (Ring)	same as 9.1 plus OC-12 path-switched ring and OC-1 local drop	same as 9.1 plus OC-3 ring to OC-12 ring
13.0 (Ring)	same as R11.0	same as R11.0
11.1 (Ring)	same as R13.0	same as R13.0
15.0 (Ring)	same as R13.0	same as R13.0

Note: See "OC-3 Ordering — Plug-Ins" tab for plug-in compatibilities.

Table 6-2. Current DDM-2000 OC-12 Multiplexer Topology Upgrades (Note)

Software Release	Supported Topologies	Topology Upgrades Supported (In-Service)
1 (linear)	point-point and OC-12 hub	point-point → OC-12 hub
2 (linear)	as above	as above
3.0 (Ring)	STS-1 path switched ring with STS-1 drop and continue	point-point → STS-1 path switched ring
3.1 (Ring)	same as R3 plus STS-1 and VT1.5 path switched ring	point-point → STS-1 path switched ring OC-3 path switched ring → OC-12 path switched ring
5.0 (Ring)	same as R3.1 plus optical extensions, drop and continue to OC-3, and STS-3c path switched ring	as above
5.1 (Ring)	same as R5.0	as above
5.2 (Ring)	same as R5.1 plus STS-3c 0x1	as above
7.0 (Ring)	same as R5.2	as above

Note: See "OC-12 Ordering — Plug-Ins" tab for plug-in compatibilities.

DDM-2000 OC-3 to OC-12 Capacity Upgrades

OC-3 point-to-point, STS-1 drop, hub, or ring installations can be upgraded in-service to the OC-12 line rate using the DDM-2000 OC-12 Multiplexer. In order to accomplish this, the OC-12 Multiplexer should be equipped for the configuration it is expected to serve (point-to-point, linear taper, hub, or ring). If a point-to-point upgrade is planned, the cutover is achieved by first establishing the OC-12 span on the protection fiber pair (or spare), equipping the protection slots with IS-3 circuit packs, and connecting the link between the DDM-2000 OC-3 and DDM-2000 OC-12 Multiplexers (Figure 6-1). Traffic is then cut over to the IS-3/ OC-12 path by a forced switch command. The procedure is then completed by equipping the service slots with IS-3 cards and connecting the link. For path-switched ring applications, a DDM-2000 OC-3 Multiplexer can be equipped with OC-12 optics in the main slots to provide an OC-12 path-switched ring capable of dropping up to 3 STS-1 equivalent traffic. If more than 3 STS-1 capacity must be dropped at a particular site, multiple OC-3 multiplexers equipped with OC-12 optics can be connected in tandem to provide the desired capacity or the site can be converted to an OC-12 Multiplexer as described above. The OC-3 Multiplexer is upgraded to OC-12 by first upgrading the software to a version that supports the OC-12 interface. Then remove a main OC-3 Optical Line Interface Unit (OLIU) and replace it with an OC-12 OLIU after switching all traffic to the other ring interface. Next remove the main OC-3 OLIU on the adjacent OC-3 Multiplexer shelf that connects to the OC-12 OLIU on the first shelf. Insert an OC-12 OLIU in the second shelf so that now both ring directions can carry service, one through an OC-3 span and the other through the new OC-12 span. This process is repeated until all OC-3 spans are converted to OC-12.

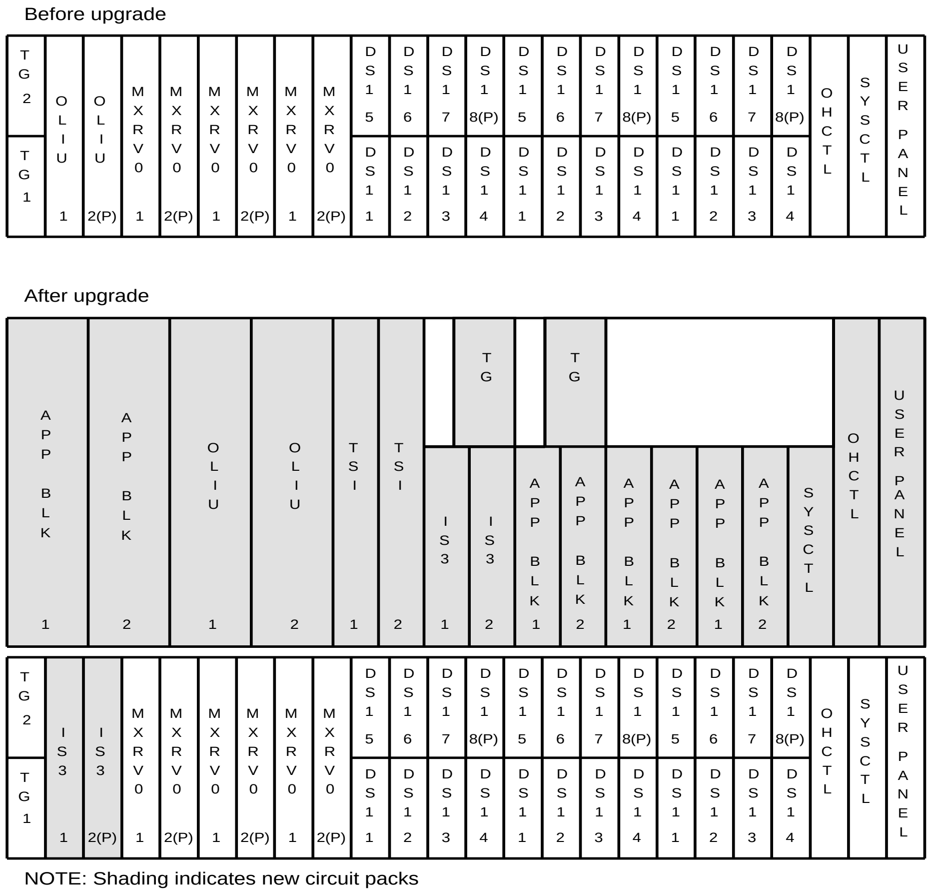


Figure 6-1. Point-to-Point OC-3 to OC-12 Upgrade

Topology Evolutions

General

One of the key advantages in deploying the DDM-2000 OC-3 and OC-12 Multiplexers is a seamless evolution from simpler topologies, like point-to-point, to advanced DS1 add/drop and self-healing rings. This flexibility means the initial investment in the DDM-2000 OC-3 and OC-12 Multiplexers and technician training are preserved through the stages of long-term network evolution. The DDM-2000 OC-3 and OC-12 Multiplexers have many unique hardware and software features to accomplish this flexibility, such as a compact shelf design with on-board power supplies, multiuse function slots, reusable shelves and circuit packs between different topologies, and remote software download on top of a powerful control platform.

OC-3 Point-to-Point Upgrade to STS-1 Drop and OC-3 Hubbing

Initial OC-3 point-to-point installations can be upgraded in service to the loop-optimized STS-1 drop and OC-3 hubbing applications in a straightforward procedure (Figure 6-2). If this upgrade is expected, the C function unit position should be reserved for the first OC-3 extension from the remote site. The A and B slots can contain MXRVO packs (plus accompanying DS1 packs), DS3, or STS1E circuit packs initially; following the upgrade, OLIU circuit packs may be installed in the A and B slots for additional OC-3 extensions.

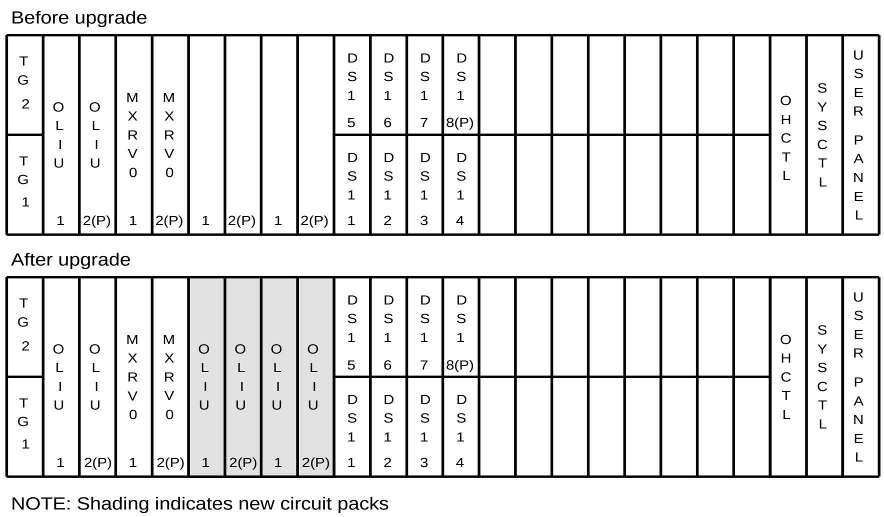


Figure 6-2. OC-3 Point-to-Point to OC-3 Hubbing Upgrade

Default Routing

The STS-1 signals are default-routed within the remote DDM-2000 OC-3/OC-12 Multiplexer initially. The STS-1 #1 will be default-routed between main and A if A is equipped. Similarly, STS-1 #2 defaults to the B slot if B is equipped and STS-1 #3 defaults to C if C is equipped. The default routing connections are designed to provide a useful level of automatic provisioning without permitting signals to have multiple connection options that could result in unintentional service disruptions. A manual routing feature is also provided that allows the default-routed STS-1 signals to be overridden to accommodate other configurations. With this feature, STS-1 #1 and STS-1 #2 can be manually routed between main and C. As discussed previously, a capacity upgrade for these topologies can also be accomplished in-service.

OC-12 Point-to-Point Upgrade to OC-12 Hubbing

As with the DDM-2000 OC-3 Multiplexer, the DDM-2000 OC-12 Multiplexer provides the capability to upgrade topologies in service. Thus an OC-12 Multiplexer can be upgraded in service from a point-to-point configuration to a hub by the simple addition of optical extensions at the OC-3 rate in the function slots (Figure 6-3). There is a fixed mapping between the STS-1s on the OC-12 line and the function unit they are mapped into. Future releases will allow flexible bandwidth assignment across an STS-12 by replacing the STS-1 cross-connect pack with a new pack that allows STS-1 time slot interchange (TSI).

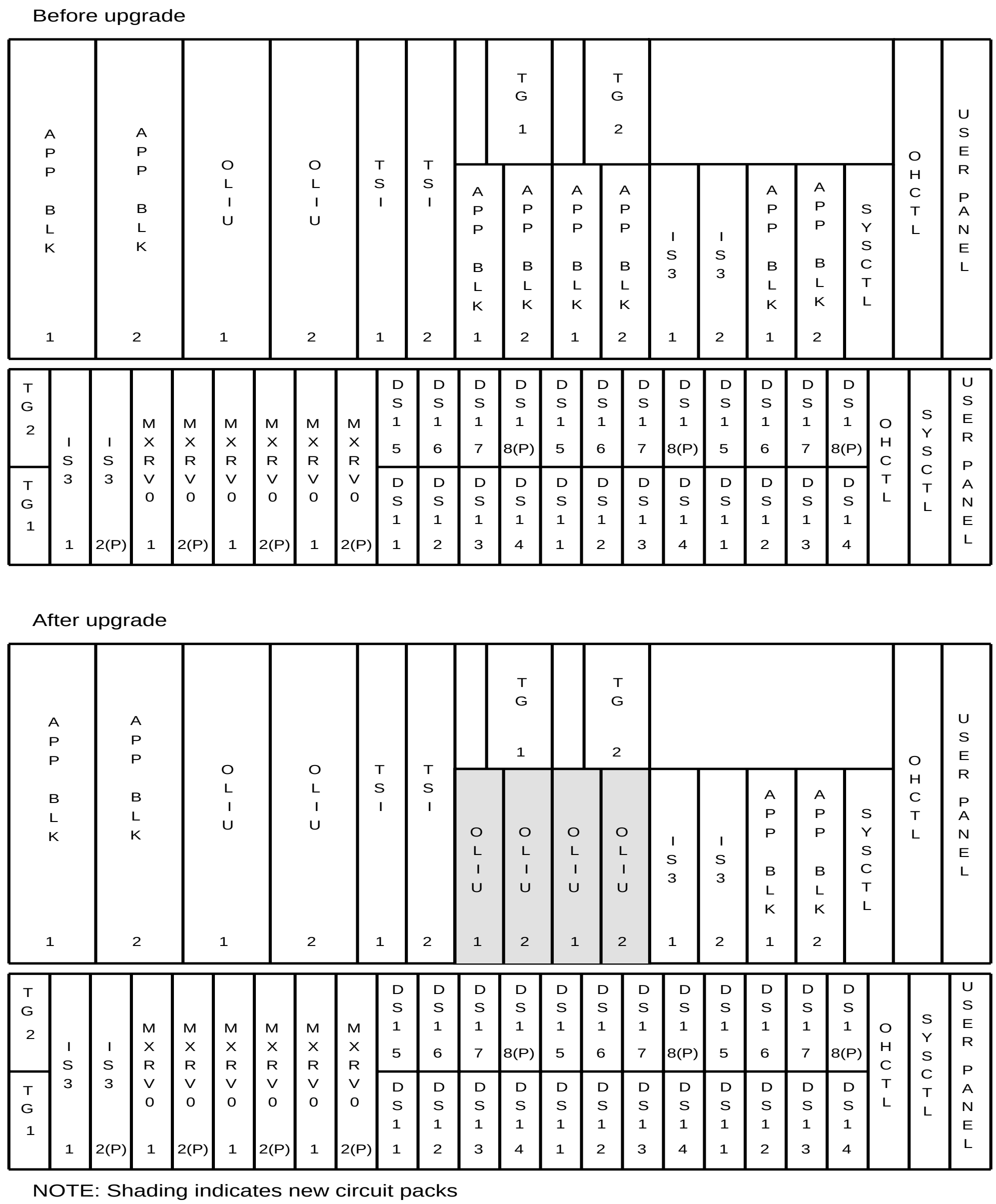


Figure 6-3. OC-12 Point-to-Point to OC-12 Hubbing Upgrade

OC-3 Upgrade to DS1 Add/Drop

The same DDM-2000 OC-3 Multiplexer that supports point-to-point applications also provides the enhanced bandwidth management of DS1 add/drop, with just a few circuit pack changes (Figure 6-4).

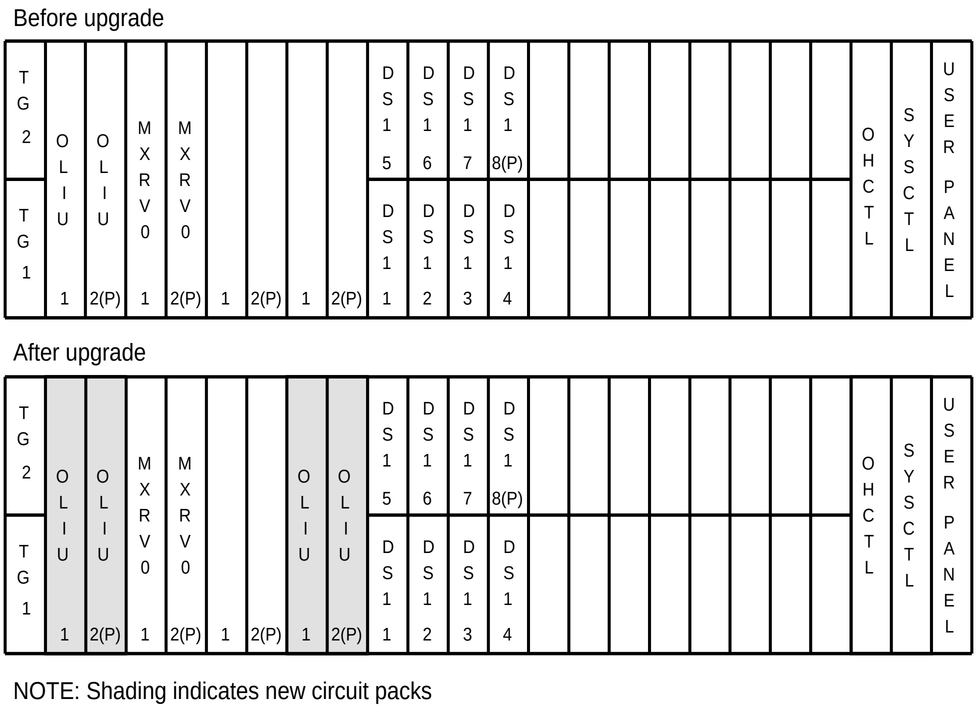


Figure 6-4. OC-3 Point-to-Point to OC-3 DS1 Add/Drop Upgrade

The add/drop and TSI functions of the DDM-2000 OC-3 Multiplexer are implemented on the 22-type (22F, 22D-U, 22G-U/22G2-U/22G3-U) OLIU circuit pack. When virtual tributary (VT) level add/drop or grooming is used in a shelf, the 22-type OLIU is used for all OC-3 interfaces. For example, in a loop application, it may be preferable to groom services at each remote site, for maximum packing efficiency of the facility. Thus, 22-type OLIUs would be used in each remote site, while the central office (CO) DDM-2000 OC-3/OC-12 shelf may continue to operate as a fixed-mapping terminal with the 21-series (21G/21G-U/21G2-U and 21D/21D-U) OLIU.

The TSI function of the DDM-2000 OC-3 Multiplexer supports a complete set of cross-connects needed by the network planner. For linear add/drop applications, with 22-type OLIUs in the Main and C positions, any low-speed time slot from the A or B position (DS1 interface or VT1.5 within an EC-1) can be connected to any of the 84 VT1.5 time slots in the Main or C position's OC-3 interface. In hubbing applications, low-speed VT1.5 tributaries within an A or B position 22-type OLIU may also be assigned to any Main or C position time slot.

Furthermore, pass-through traffic may be groomed between different time slots on the Main and C OC-3 interfaces. This pass-through grooming, which is not supported by systems limited to time-slot assignment (TSA), allows in-transit bandwidth rearrangements for maximum facility utilization. This grooming is most useful for networks with intersite routing (for example, interoffice or private networks) and networks with significant churn (service removal as well as new service installation).

The TSI does not currently support intrasite "hairpinning" between time slots on the same multiplexed interface or between time slots of the A and B low-speed positions.

OC-12 facilities can also be added to an existing OC-3 add/drop network. Initial OC-3 add/drop sites are upgraded to OC-12 by adding a co-located DDM-2000 OC-12 Multiplexer, creating a DS1-to-OC-12 add/drop Multiplexer. The DDM-2000 OC-3 and OC-12 Multiplexers' VT1.5 and STS-1 TSI capabilities allow continued bandwidth management as the network capacity expands.

The OC-3 and OC-12 linear applications (that is, point-to-point, drop, add/drop, and OC-12 Regenerator) can be upgraded to a self-healing ring topology. Some fiber facility rearrangements and protection switching will be necessary to establish the counter-rotating traffic path. The upgrade from a point-to-point or DS1 drop network to a ring will be an in-service upgrade if the cross-connections need to be established at the VT level; otherwise, it can be up to 1 second of outage time.

DDM-2000 OC-3/OC-12 has the distinct advantage of being able to be upgraded from a DS1 add/drop configuration to a self-healing ring without replacing any circuit packs.

OC-3 Linear Network Upgrade to OC-3 Ring

OC-3 point-to-point, STS-1 drop, or DS1/STS-1 add/drop topologies can easily be upgraded to an OC-3 ring. If the topology is point-to-point or STS-1 drop, the upgrade can be done in-service. The point-to-point or STS-1 drop topologies need the 22-type OLIUs in the Main slots, if not already equipped; otherwise, the upgrade to a ring requires no new hardware. Function slots can be equipped with DS3, MXRVO/DS1, or STS1E circuit packs during the upgrade.

OC-12 Point-to-Point Upgrade to OC-12 Ring

The DDM-2000 OC-12 Multiplexer can be upgraded in service from a point-to-point topology to a ring. This is done by downloading the ring software and changing the BCP2 TSI circuit pack with the BCP3 TSI (Figure 6-5). The BCP3 TSI circuit pack provides fully flexible cross-connections of STS-1 signals.

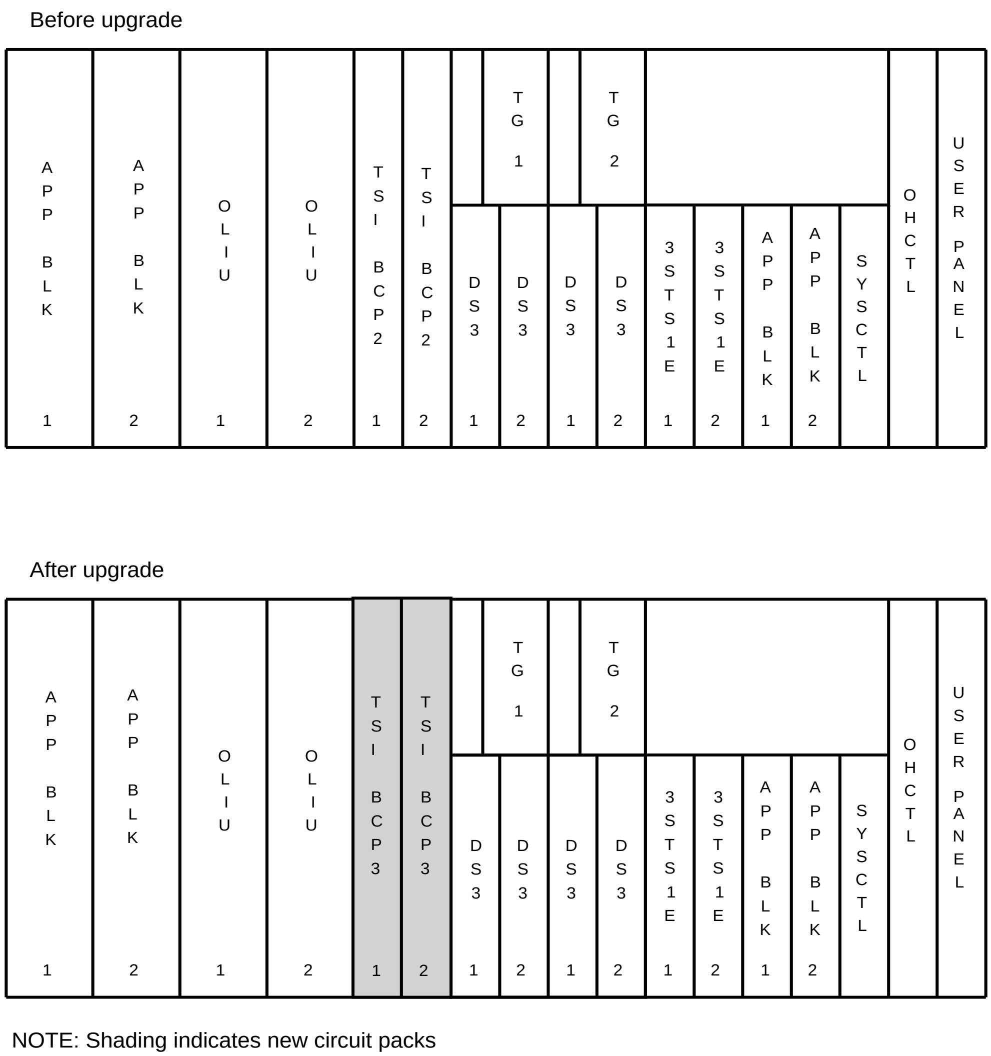
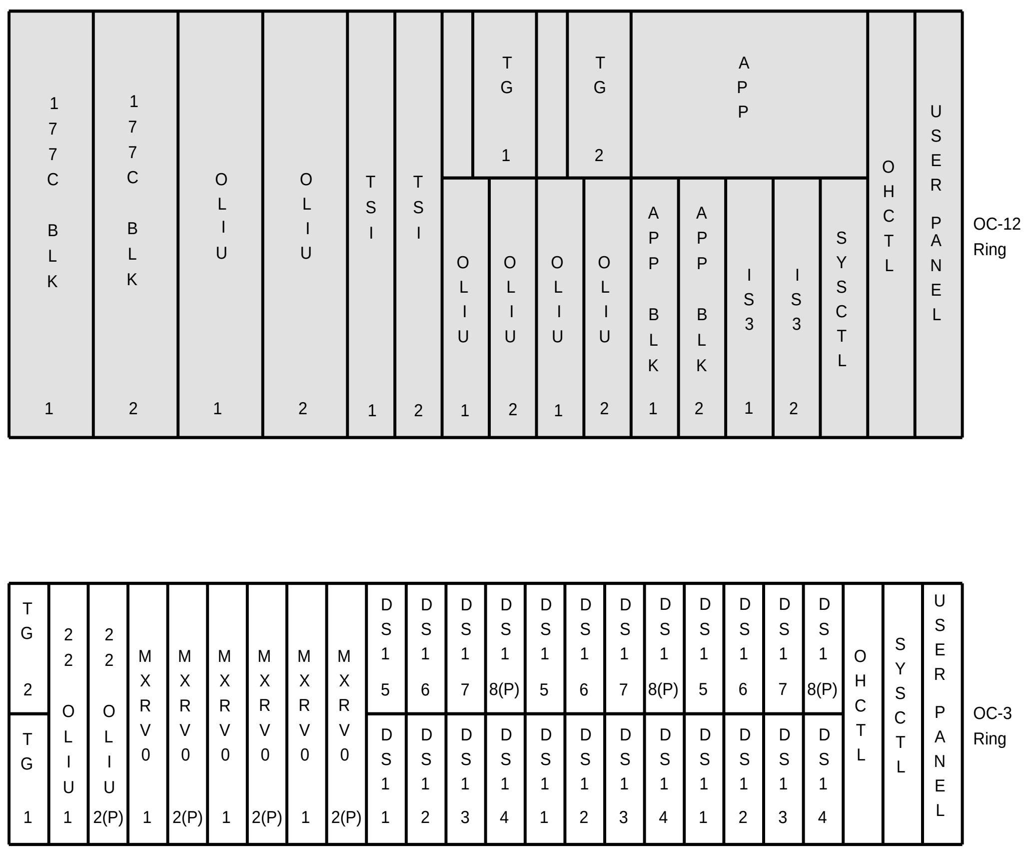


Figure 6-5. OC-12 Point-to-Point to OC-12 Ring Upgrade

OC-3 Ring to OC-12 Ring Upgrade

A DDM-2000 OC-3 Multiplexer ring can be upgraded in service to a DDM-2000 OC-12 ring. A protection switch hit may occur for each unidirectional service depending on how traffic is currently being selected on the ring. Each site requires the addition of a DDM-2000 OC-12 Multiplexer shelf (Figure 6-6).

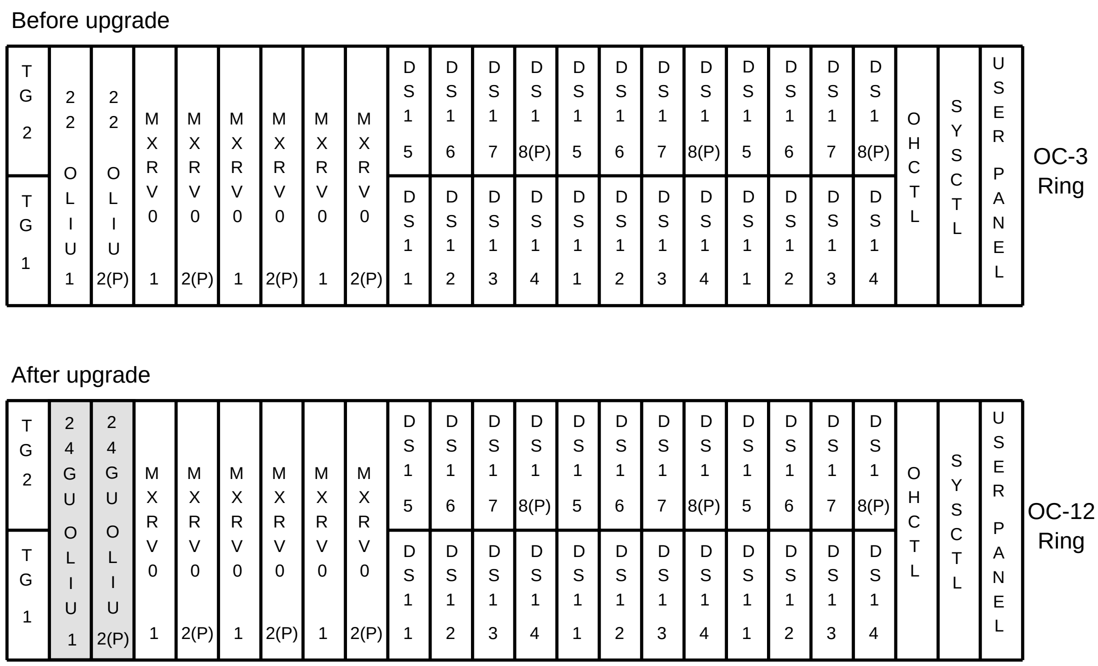


NOTE: Shading indicates new circuit packs

Figure 6-6. OC-3 Ring to OC-12 Ring Upgrade

OC-3 Ring to OC-12 Ring Capacity Upgrade

A DDM-2000 OC-3 Multiplexer ring can be upgraded in-service to a DDM-2000 OC-12 ring. This is done by replacing the 22-type OLIUs in the Main positions with the 24G-U/24H-U or 29G-U/29H-U OLIUs. Note that BBG8B and BBG9 OHCTLs and Release 11.0/11.1 (22-type OLIUs), Release 13.0 (24-type OLIUs), and Release 15.0 (29-type OLIUs) software are required for this application. See Figure 6-7.



NOTE: Shading indicates new circuit packs

Figure 6-7. OC-3 Ring to OC-12 Ring Capacity Upgrade

DDM-2000 OC-3/OC-12 Path Switched Ring to FT-2000 OC-48 Lightwave System Line Switched Ring

The Lucent 2000 Product Family offers upgradability from OC-3 and OC-12 line rates to the OC-48 rate. Such an upgrade may be needed in large metropolitan areas or in applications where new broadband services are deployed in large numbers. The Lucent 2000 Product Family protects the user from being locked in at either the OC-3 or OC-12 signal rates by offering an upgrade to the OC-48 rate, using the FT-2000 OC-48 Lightwave System. An EC-1 or OC-3 interface can be used to connect the FT-2000 OC-48 Lightwave System to either a DDM-2000 OC-3 or OC-12 Multiplexer.

A DDM-2000 OC-3/OC-12 Multiplexer ring can be upgraded in service to an FT-2000 OC-48 Lightwave System line switched ring. A protection switch hit may occur for each unidirectional service depending on how traffic is currently being selected on the ring. Each site requires the addition of an FT-2000 OC-48 Lightwave System ring shelf. For DDM-2000 OC-12 Multiplexer upgrades, the OC-12 shelves can be removed after the upgrade.

Interworking with *SLC*-2000 Access System

With its SONET-compliant facility shelf, the *SLC*-2000 Access System can be configured as an OC-3 terminal or self-healing ring add/drop multiplexer (ADM). Therefore, separate DDM-2000 OC-3 Multiplexers and *SLC* series 5 carrier systems remote terminals (RTs) can be replaced in some future terminal and ring sites by a single *SLC* 2000 Access System RT. Note that the *SLC*-2000 Access System RT will only supply 28 DS1 low-speed outputs for extension via DDM-Plus; sites that exceed 28 DS1 demand should be served by a combination of DDM-2000 OC-3/OC-12 and *SLC*-2000 Access Systems.

The DDM-2000 OC-3 Multiplexer will be also be co-located with a *SLC*-2000 Access System RT for linear add/drop and fiber hubbing nodes where the "collapsed ring" architecture is not an option. OC-12 networks will use the DDM-2000 OC-12 system co-located with *SLC* 2000-Access Systems and optional DDM-2000 OC-3 Multiplexers for delivery of more than 28 DS1 services.

Optical Link Engineering

The DDM-2000 OC-3 and OC-12 Multiplexers and the OC-12 Regenerator provide a variety of optical interfaces with a large range of span lengths, fiber types, and wavelengths. DDM-2000 OC-3 OLIUs can be mixed on opposite ends of a link in a variety of ways. Technical details and engineering guidelines for these optical interfaces can be found in Section 11, "Technical Specifications."

Synchronization

Network Synchronization Environment

Careful consideration should be given to proper design of the SONET network's synchronization environment. Proper synchronization engineering minimizes timing instabilities, maintains quality transmission network performance, and limits network degradation due to unwanted propagation of synchronization network faults. The synchronization features of the DDM-2000 OC-3/OC-12 are designed to complement the existing and future synchronization network and, hence, allow it not only to make use of network timing but also to take on an active role in facilitating network synchronization. A number of published sources give generic recommendations on setting up a synchronization network. The DDM-2000 OC-3/OC-12 is designed to operate in a network that complies with recommendations stated in TR-NPL-000436, *Digital Synchronization Network Plan*; TA-TSY-000378, *Timing Signal Generator (TSG) Requirements and Objectives*; and *ANSI* * T1.101-1993 (letter ballot), *Synchronization Interface Standards for Digital Networks*. The following are some key recommendations from these documents. For further detailed explanation, the sources should be consulted directly.

1. A node can only receive the synchronization reference signal from another node that contains a clock of equivalent or superior quality (stratum level).
2. The facilities with the greatest availability (absence of outages) should be selected for synchronization facilities.
3. Where possible, all primary and secondary synchronization facilities should be diverse, and synchronization facilities within the same cable should be minimized.
4. The total number of nodes in series from the stratum 1 source should be minimized. For example, the primary synchronization network would ideally look like a star configuration with the stratum 1 source at the center. The nodes connected to the star would branch out in decreasing stratum level from the center.
5. No timing loops may be formed in any combination of primary and secondary facilities.

* Registered trademark of American National Standards Institute.

The DDM-2000 OC-3/OC-12 can support two timing generator circuit packs: TG3 (stratum 3 timing generator) and TGS (synchronous timing generator). The TGS operates with an internal oscillator of ±15 ppm long term accuracy in the free-running mode, while in holdover the accuracy is ±8.8 ppm over the full -40 to +75°C temperature range. The TG3 operates with an internal oscillator of ±4.6 ppm long term accuracy in the free-running mode, while in holdover the accuracy is ±.37 ppm over the full -40 to +75°C temperature range. The clock accuracy of the DDM-2000 OC-3/OC-12 with a TGS is between stratum 3 and stratum 4, SONET Minimum Clock (SMC) as defined by Telcordia Technologies. Both the TGS and TG3 should be used according to the recommendations in documents referenced previously.

Special considerations specific to digital loop carrier (DLC) systems, like the *SLC*-2000 Access System, must be taken into account when planning the synchronization environment when these DLC systems are included in a SONET subnetwork. See 363-208-000, *SLC-2000 Access System, Applications, Planning, and Ordering Guide*, for more information.

DDM-2000 OC-3/OC-12 Synchronization Features

Timing Modes

As the present asynchronous network evolves toward the synchronous optical network (SONET), the DDM-2000 OC-3/OC-12 Multiplexers can be used in a number of synchronization environments. In support of this evolution, each DDM-2000 OC-3/OC-12 Multiplexer can be provisioned to free run from an internal oscillator, line time from an incoming high-speed interface, or get external timing from the digital synchronization network via DS1 references. A loop timing configuration can be achieved by provisioning the timing generator TGS/TG3 (either a TGS BBF2B or stratum 3 TG3 BBF4) circuit pack to the loop timing mode. Loop timing is the same as line timing, except it is defined for a terminal network element (NE) as opposed to line timing defined for an intermediate NE. These timing modes can be combined into three subnetwork configurations: free running/loop timing, external timing/loop timing, and external timing (synchronous or plesiochronous). As the digital synchronization network expands and evolves, networks can be upgraded in-service among these configurations. For example, the free running configuration can be upgraded in-service to the external timing configuration by simply providing two DS1 references to the TGS/TG3 circuit packs and setting a hardware switch.

External Timing

In the external timing mode, the TGS/TG3 circuit pack accepts two DS1 references from an external stratum 3 or better clock. This stratum 3 (or better) clock would typically be traceable to a primary reference source (PRS). The DS1 references from the clock synchronize the local DDM-2000 OC-3/OC-12 Multiplexer with other network equipment operating under the same primary clock source. In the TGS/TG3, a highly stable digital phase-locked loop (DPLL) circuit removes any transient impairments on the DS1 reference for improved jitter/wander performance.

The PRS is equipment that provides a timing signal whose long-term accuracy is maintained at 10^{-11} or better with verification to universal coordinated time (time and frequency standard maintained by the US National Institute of Standards and Technology), and whose timing signal is used as the basis of reference for the control of other clocks in a network.

The DS1 reference inputs are monitored for error-free operation. If the selected reference becomes corrupted or unavailable, the TGS/TG3 circuit pack will switch to the protection reference without causing service degradations. A switch to the protection reference is nonrevertive. If both DS1 inputs are corrupted, the DPLL circuit holds the on-board oscillator frequency at the last good reference sample (holdover). The TGS/TG3 will switch back to the external timing mode when a reference is no longer corrupted, but it can be provisioned to require a manual switch. Switching between the two DS1 reference inputs can also be done using a manual command.

Line Timing

The terms loop timing and line timing have been changed to clarify timing terminology. When the OLIU derives local shelf timing from the incoming optical signal and the shelf is an intermediate shelf (choice of OC-N lines for timing) in a linear network for example, it is called line timing. Loop timing is a subset of line timing used to describe the timing mode of the terminating node of a linear network.

In line timing mode, the TGS/TG3 circuit pack derives local shelf timing from the incoming service OC-1, OC-3, or OC-12 high-speed signal in the Main slot. The DDM-2000 OC-3 Multiplexer can also recover timing from the "C" function unit slot (OC-3 signal only) via a craft interface terminal (CIT) command. The TGS/TG3 circuit pack accepts a recovered clock from the OLIU circuit pack, from which it derives the internal clock used by the transmission packs. In line timing mode, the TGS/TG3 DPLL also serves to remove any timing transients for improved network jitter performance. If one of the OC-N references is corrupted or unavailable, the TGS/TG3 will make a nonrevertive protection switch to the other reference without causing timing degradations. If all OC-N timing signals are lost (for example, due to a cable cut), the TGS/TG3 circuit pack will switch to holdover mode. The TGS/

TG3 will normally switch back to the line timing mode when a reference is no longer corrupted, but it can be provisioned to require a manual switch.

In a linear network topology, the OC-N timing normally follows the transmission protection switching but can be provisioned independently. In a ring topology, the OC-N timing can be configured to lock to a particular ring rotation or, for the DDM-2000 OC-3 Multiplexer, to Function Unit C slot. Line timing is the provisioned mode used for DDM-2000 OC-3/OC-12 systems that are placed in a loop timed configuration. Automatic synchronization allows the automatic reconfiguration of line timing.

TGS Free Running

In free running mode, no mode switching is performed. The TGS derives its timing from a crystal oscillator that has an end of life performance of ±15 ppm. Only one DDM-2000 OC-3/OC-12 in a subnetwork can be provisioned in the free running mode. All other DDM-2000 OC-3/OC-12s in the subnetwork must be line/loop timed to this free running system to avoid performance degradation.

TG3 Free Running

In free running mode, no mode switching is performed. The TG3 derives its timing from a crystal oscillator that has an end of life performance of ±4.6 ppm. Only one DDM-2000 OC-3/OC-12 in a subnetwork can be provisioned in the free running mode. All other DDM-2000 OC-3/OC-12s in the subnetwork must be line/loop timed to this free running system to avoid performance degradation.

DS1 Timing Output

The DDM-2000 OC-3/OC-12 Multiplexers also support a DS1 timing output feature that facilitates network timing distribution. The DS1 timing output is derived from the OC-N line rate, therefore, it is not subjected to multiplexing or pointer processing effects. The result is a DS1 traceable to the far-end source with extremely low jitter and wander. The timing output can follow the protection switching of the OC-N line, be locked to a specific OC-N, or be automatically controlled using synchronization messaging. Existing DDM-2000 OC-3/OC-12s can be upgraded in service to provide DS1 timing outputs to an external clock using the BBF2B TGS or BBF4 TG3 circuit pack. The line coding and frame format on the DS1 output and input is provisionable. Provisioning options include specifying alternate mark inversion (AMI) or bipolar 8-zero substitution (B8ZS) line coding and superframe format (SF) or extended SF (ESF). The DS1 is a framed all-ones signal under normal conditions or an AIS signal under failure conditions.

DS1 Reference Cascading (MULT mode)

In a central office environment where multiple DDM-2000 OC-3/OC-12 Multiplexers are installed in a network bay frame, a pair of DS1 timing references from the local office clock can be shared by all shelves in the bay. This unique reference cascade feature reduces the number of clock ports needed to synchronize multiple DDM-2000 OC-3/OC-12 Multiplexers, thus minimizing network costs.

Each DDM-2000 OC-3/OC-12 provides two DS1 input ports and two DS1 output ports that reflect the DS1 signal appearing at the input ports. This cascade (MULT) feature reduces the number of clock ports needed to synchronize multiple DDM-2000 OC-3/OC-12 Multiplexers, thus minimizing network costs. This feature can be started on the second DDM-2000 OC-3/OC-12 shelf in a bay if the first shelf is using the DS1 timing output feature.

Subnetwork Configurations

TG3 and TGS Compatibility

TG3 and TGS timing generators must be used according to the stratum timing rules. These rules state that a clock may be synchronized by another clock of equal or higher stratum. The TG3 operates at a higher stratum level than the TGS. This means that a DDM-2000 containing TGS circuit packs can not supply timing to a DDM-2000 containing TG3 circuit packs. In a typical network configuration, TG3 packs would be located in the host node. Remote nodes would either contain all TGS or all TG3 packs. In general, remote nodes containing TG3 packs must have traceable timing back to a host containing TG3 packs including all remote nodes in the path. If a network contains two externally-timed host nodes, both hosts must contain TG3 packs to use TG3 packs in the remote nodes. TG3 and TGS circuit packs may not be mixed in the same shelf under normal operating conditions. Mixing is allowed during upgrade procedures only.

Free Running/Line Timing

For initial SONET deployment with DS1 and/or DS3 low-speed interfaces, minimum first cost may be a primary concern. The free running/line timing network can operate without an external clock source, so the expense of connecting to one is eliminated. This configuration may be useful for initial loop feeder and customer location applications, and also meets the needs of an end-office trunk facility. This configuration should not be used to provide OC-N timing distribution or where SONET interconnections to other SONET subnetworks are needed. The local DDM-2000 OC-3/OC-12 Multiplexer times its transmitted signals at the low- and high-speed interfaces from the internal ±15 ppm oscillator in the TGS or ± 4.6 ppm for the TG3. The remote DDM-2000 OC-3/OC-12 Multiplexer recovers timing from the incoming OC-N signal and uses this timing for its transmitted signals.

Because the free running/loop timed DDM-2000 OC-3/OC-12 network is asynchronous to the DS1/DS3 services carried over it, additional jitter will be experienced on the demultiplexed DS1s/DS3s. Certain interconnected equipment may be sensitive to such jitter and this configuration should not be used in cases where it would cause a problem for that equipment. In particular, downstream equipment containing stratum 3 or better clocks could be sensitive to this jitter.

Figure 6-8 shows a DDM-2000 OC-3/OC-12 Multiplexer point-to-point application. The free running/loop timing configuration can also be used for multispan applications, like the STS-1 drop application in Figure 6-9. The intermediate node in this subnetwork performs line timing, whereby, both transmitted OC-N lines are timed from an incoming OC-N. Care should be taken to ensure that all the line/ loop timed DDM-2000 OC-3/OC-12s in a subnetwork are provisioned in a consistent direction to prevent the formation of timing loops.

NOTE:
The synchronization and timing examples used throughout this chapter reference the timing generators as “TG.” This could represent either the BBF2B TGS or the stratum 3 BBF4 TG3.

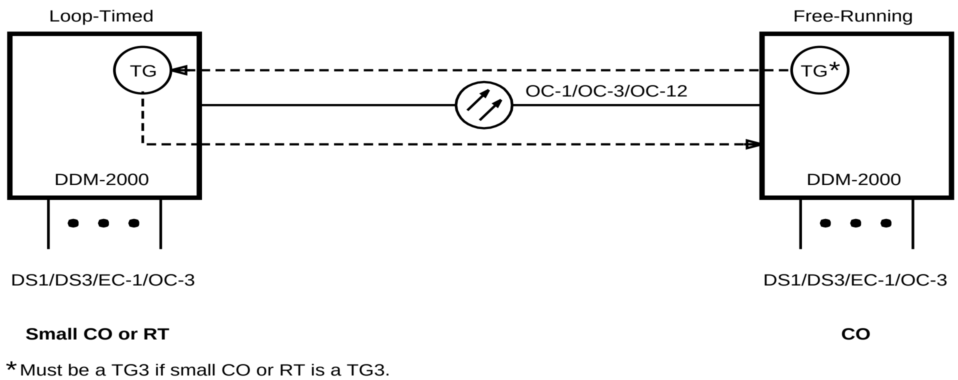


Figure 6-8. Free Running/Loop Timing Configuration

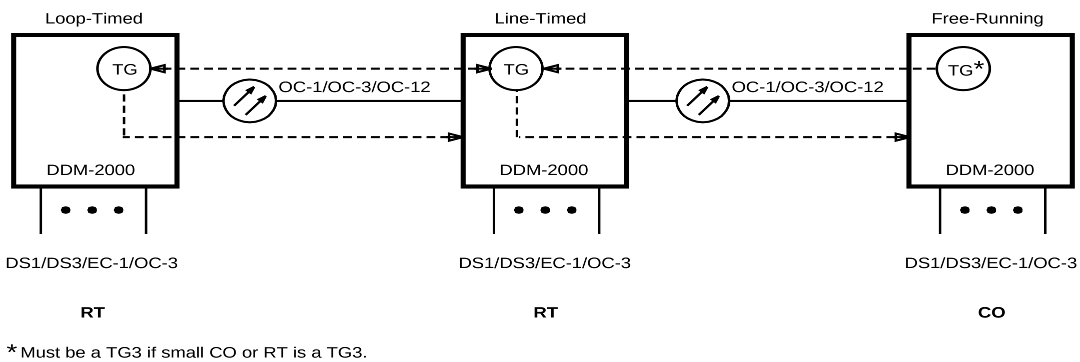


Figure 6-9. Multispan Free Running/Line Timing/Loop Timing Configuration

External Timing/Loop Timing Configuration

The external timing/loop timing configuration (Figure 6-10 for linear networks and Figure 6-11 for ring networks) integrates loop feeder and customer location networks into the digital synchronization network as required by the SONET standard. This application is ideal for networks where only one location has a building integrated timing supply (BITS) clock, for example, loop feeder. The network is synchronized to a local central office clock via DS1 references. The local office clock should be stratum 3 or better, with timing traceable to a primary reference source. The local DDM-2000 OC-3/OC-12 Multiplexer times its transmitted signals at the low- and high-speed interfaces from the internal oscillator that is locked on the external reference. The remote DDM-2000 OC-3/ OC-12 Multiplexer recovers timing from the incoming OC-N signal and uses this timing for its transmitted signals.

External timing is required when EC-1 low-speed interfaces are used to interconnect the local DDM-2000 OC-3/OC-12 with other SONET equipment. Thus, the external timing/loop timing configuration should be the long-term goal for all loop feeder and customer location applications.

This timing configuration is recommended for multispan topologies. Line timing can be extended to many DDM-2000 OC-3/OC-12 sites without any degradation of timing quality. In the ring topology, synchronization messaging allows automatic synchronization reconfiguration in the event of a fiber or equipment failure.

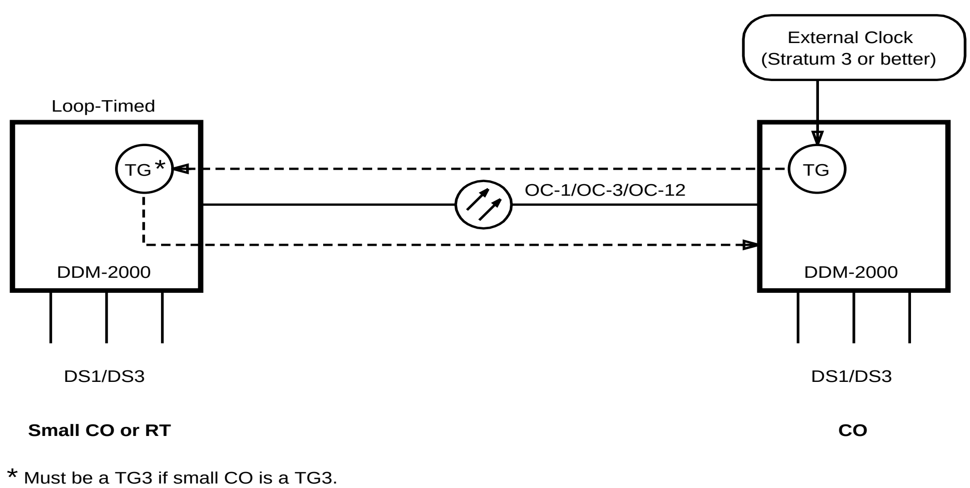


Figure 6-10. External Timing/Loop Timing Configuration — Linear Network

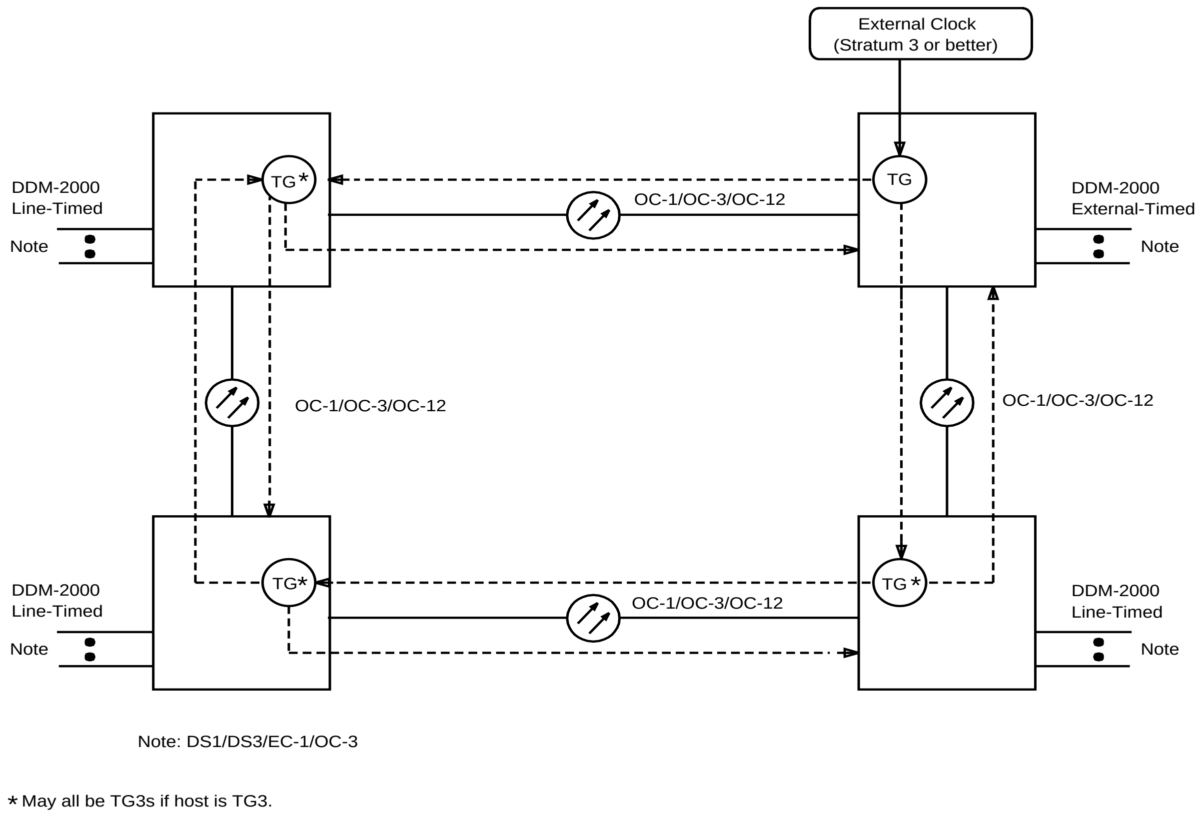


Figure 6-11. External Timing/Line Timing Configuration — Ring Network

External Timing Configuration

The external timing configuration (Figure 6-12 for linear networks and Figure 6-13 for ring networks) uses external DS1 timing to each DDM-2000 OC-3/OC-12 Multiplexer in the network. Since it requires local office clocks at each site, it is most suited to interoffice applications. A DDM-2000 OC-3/OC-12 network may have all DS1 references traceable to a common primary reference source (for example, outstate trunking) referred to as synchronous, or to multiple primary reference sources (for example, a carrier-to-carrier interface). The multiple primary reference source case is referred to as *plesiochronous* operation.

A tributary signal (for example, DS1) that traverses several plesiochronous regions may encounter increased STS-1 and VT pointer adjustments compared to that encountered in a synchronous environment. These pointer adjustments may increase jitter on the tributary when dropped from the SONET network. While standard jitter generation limits are perfectly acceptable for most service needs, some data services for example, Digital Data Service (DDS) or other equipment may be particularly sensitive to jitter-induced degradations. Therefore, it is generally desirable to minimize the number of plesiochronous regions within a network, through stratum 1 clock traceability and line timing of remote SONET elements.

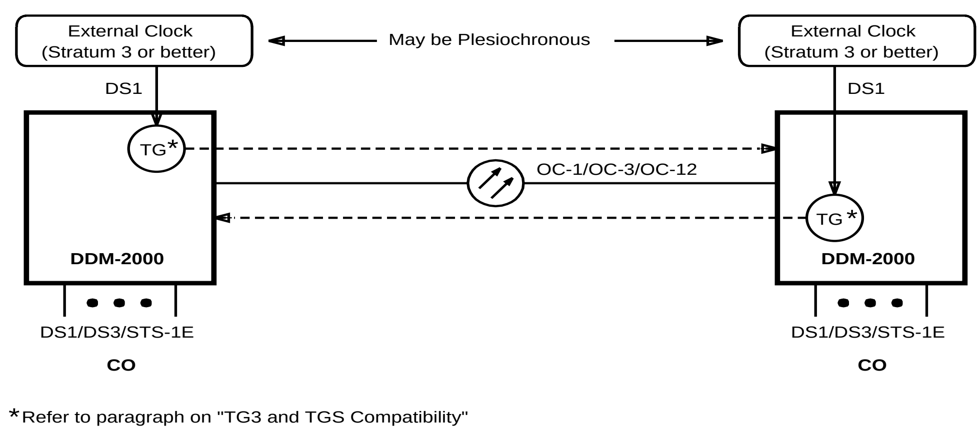


Figure 6-12. External Timing Configuration — Linear Network

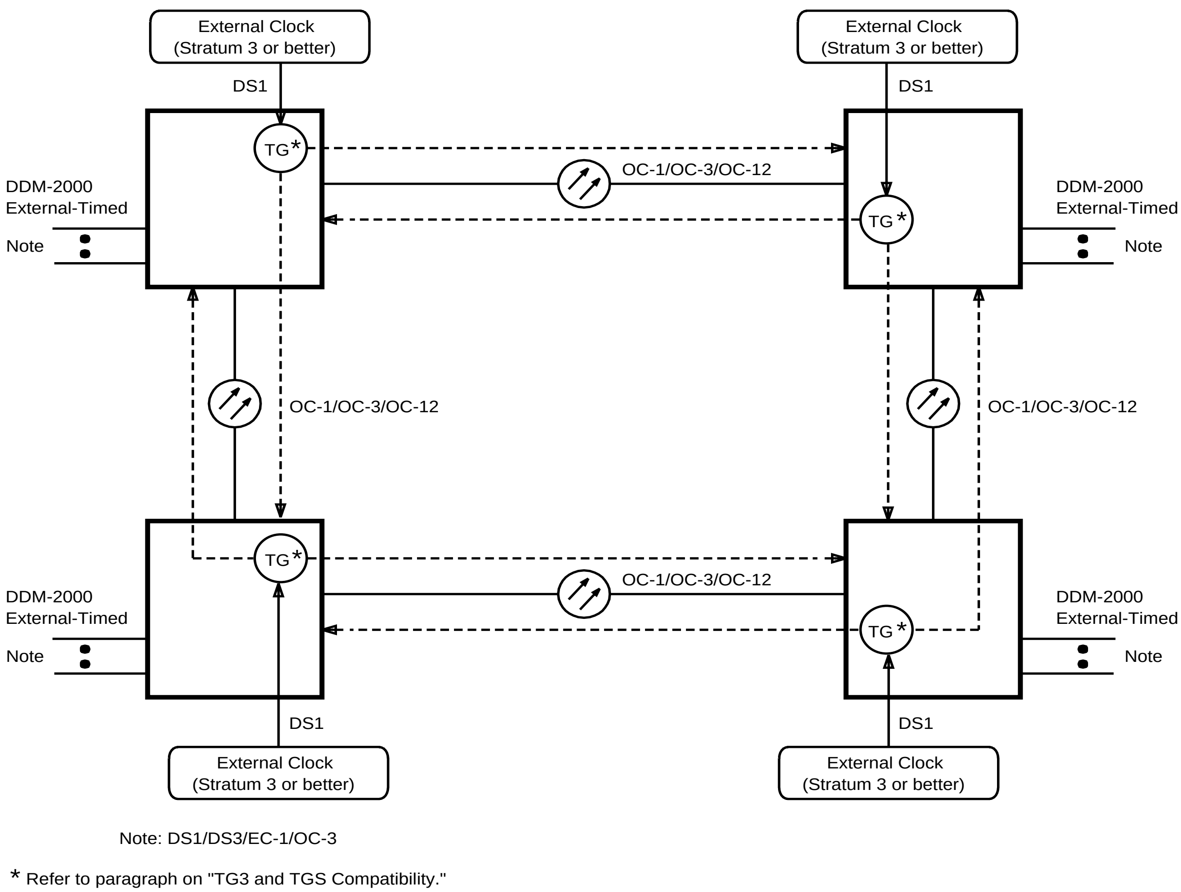
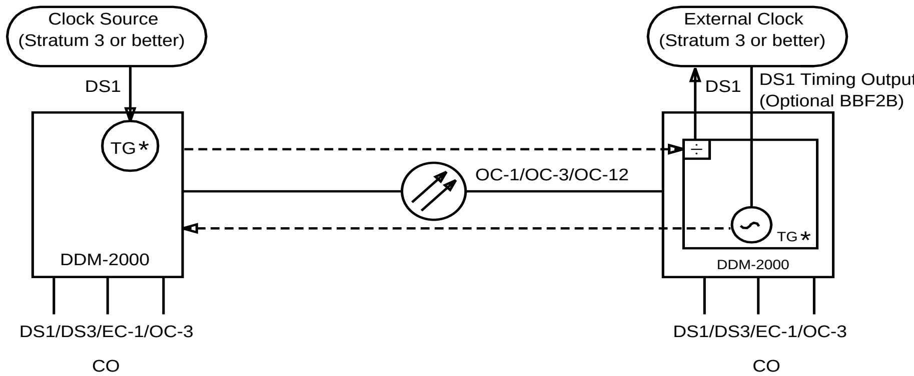
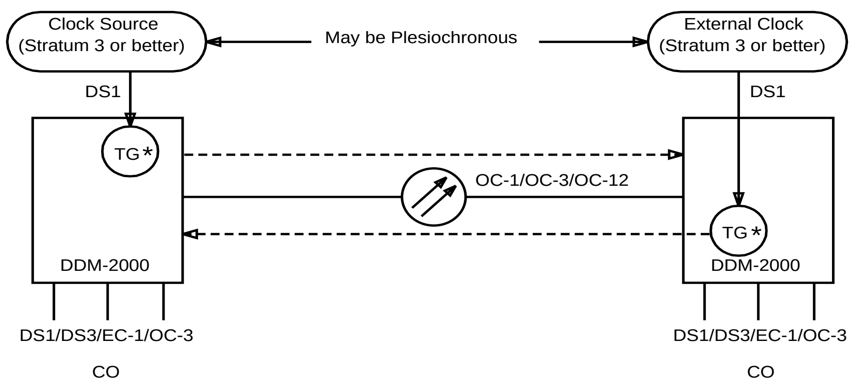


Figure 6-13. External Timing Configuration — Ring Network

External timing may be combined with the DS1 timing output feature as shown in Figure 6-14a. Note that the DS1 timing output feature and plesiochronous operation (Figure 6-14b) are mutually exclusive. Each of the network topologies (point-to-point, hubbing, linear multispan, and ring) can use external timing.



(a) External Timing Configuration



(b) External Timing Plesiochronous

* Refer to paragraph on "TG3 and TGS Compatibility."

Figure 6-14. DS1 Timing Output and Plesiochronous Timing Configurations

Network Timing Distribution

DS1 signals have long been used to pass timing information through the network synchronization hierarchy. These DS1 timing references should be transmitted between master and slave clock sources over the most reliable facilities available. In some cases, these DS1 signals also carry traffic. The facility of choice has evolved from T-carrier through asynchronous lightwave systems to SONET lightwave systems. As these systems are upgraded to SONET systems, timing distribution plans should be revisited to ensure that the quality of the timing signals are not degraded. With proper planning, SONET can be used to improve the overall quality of the network timing.

Interoffice Timing Distribution

One way SONET can be used to improve the quality of interoffice network timing is through the use of OC-N timing distribution. DDM-2000 OC-3/OC-12 supports the evolution to interoffice OC-N timing distribution by providing a DS1 timing output derived from the incoming OC-N signal. The DS1 timing output is traceable to the clock source that times the DDM-2000 OC-3/OC-12 subnetwork and has extremely low jitter and wander. This is true regardless of the number of DDM-2000 OC-3/OC-12 systems connected in the network. This DS1 can be fed to the local BITS clock which subsequently times the local DDM-2000 OC-3/OC-12 and the other equipment in the office. If a BITS clock is not available in the office, the DS1 timing output can be used to time other equipment (including another DDM-2000 OC-3/OC-12) directly. DDM-2000 OC-3/OC-12 can provide DS1 timing outputs in all supported topologies (for example, point-to-point, add/drop, and ring).

With OC-N timing distribution, the OC-N line signal, rather than a DS1 multiplexed into the SONET payload, will provide a timing transport mechanism better suited to a complex, heavily interconnected SONET network. In this configuration, a DS1 reference from the CO BITS clock still times the OC-N transmitted to the remote site; at the remote site, a DS1 output reference is created directly from the received OC-N signal (Figure 6-15).

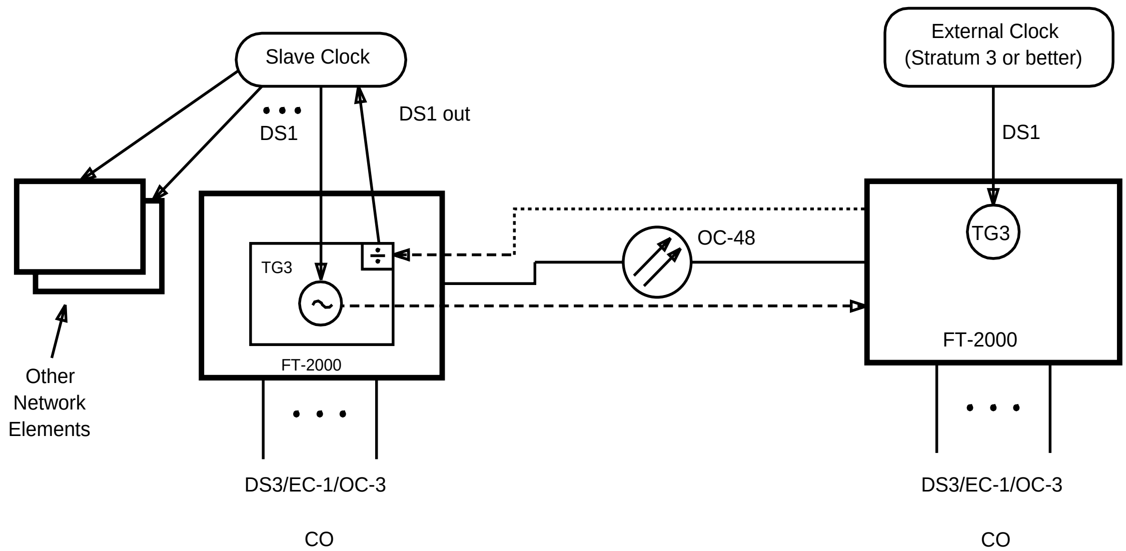


Figure 6-15. OC-N Derived DS1 Timing Reference

OC-N timing distribution has several potential advantages. It preserves transport bandwidth for customer services and guarantees a high-quality timing signal. Also, as the CO architecture evolves to replace DSX interconnects with SONET EC-1 and IS-3 interconnects and direct OC-N interfaces, OC-N distribution becomes more efficient than multiplexing DS1 references into an access facility in the CO.

A previous drawback to using OC-N timing distribution was that network timing failures could not be communicated to downstream clocks via DS1 AIS, since the DS1 signal does not pass over the OC-N interface. A standard SONET synchronization messaging scheme to convey synchronization failures is now being finalized. The DDM-2000 OC-3 and OC-12 Multiplexers already support this synchronization messaging scheme. With this option, clock stratum levels can be passed from NE to NE, allowing downstream clocks to switch timing references without creating timing loops, if a network synchronization failure occurs. If a quality timing reference is no longer available, the DDM-2000 OC-3/OC-12 sends AIS over the DS1 interface. If the local OC-N lines fail, DDM-2000 OC-3/OC-12 outputs AIS on the DS1 output or an upstream DDM-2000 OC-3/OC-12 system enters holdover.

Access Network Timing Distribution

OC-N timing distribution can also be used in access networks or to small COs. In this configuration, a DS1 reference from the CO BITS clock still times the OC-N transmitted to the remote site. The line timing capability of the DDM-2000 OC-3/OC-12 Multiplexers provides the ability to recover OC-N timing. The DS1 timing output feature can be used to also extend timing to customer networks or remote sites. In this case, the DS1 timing output can be used to time switch remotes, DDM-2000 OC-3 and OC-12 shelves, or other local equipment directly. Ideally, the equipment can provide an external timing reference. Otherwise, the signal must be input to a traffic DS1 port on the external equipment which will tie up some of this equipment's bandwidth. In this configuration, it is important that the DS1 reference to the DDM-2000 OC-3/OC-12 in the CO be traceable to the same clock used to source the DS1s being carried to the customer site or small CO. If it is not, slips may occur.

Although an ideal source of timing, OC-N timing distribution, via a DS1 timing output, cannot be used to provide timing in all applications. In cases where the local equipment is not provided with an external timing reference input, or in some private networks where the timing is to be distributed from another private network location, timing may be distributed via traffic-carrying DS1s. In these applications, a stable DS1 timing source can be achieved by ensuring that all elements in the SONET network are directly traceable to a single master clock via line timing. In this environment, the high-performance desynchronizer design of the DDM-2000 OC-3/OC-12 Multiplexer allows a DS1 timing reference to be carried as a multiplexed DS1 payload*.

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* Synchronous operation via line timing eliminates the generation of VT pointer adjustments, thus maintaining the phase stability needed for a high-quality DS1 timing reference. Cross-connecting at the STS-1 level also eliminates the VT pointer adjustments. While the design of the DDM-2000 OC-3/OC-12 Multiplexer maintains jitter/wander within standard DS1 interface requirements, even in the presence of VT pointer adjustments, and while the DS1 is likely to be stable enough for most equipment to use as a timing reference, some equipment may have more stringent stability requirements for its timing references.

It is recommended that, where possible, the DS1 sources (switch, PBX, or other equipment) be traceable to the same timing source used to time the DDM-2000 OC-3/OC-12 SONET network. Multiplexed DS1 reference transport is also consistent with current planning and administration methods. Applications include passing synchronization from the public switched network to a PBX-based private network (Figure 6-16) and synchronizing an end-office remote switch to a larger office's host switch.

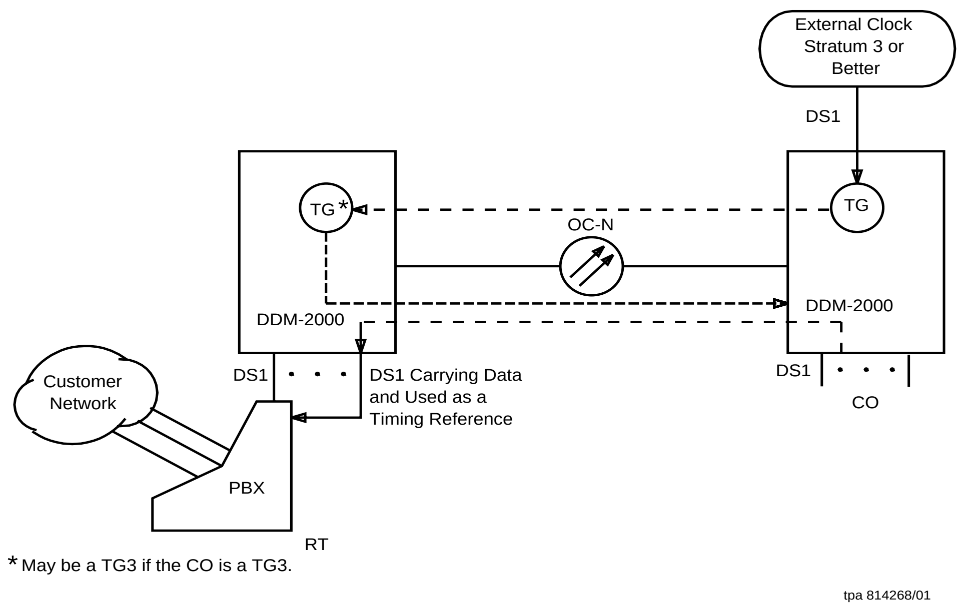


Figure 6-16. Timing from Multiplexed DS1

Synchronization Messaging

The DDM-2000 OC-3 and OC-12 Multiplexers provide a synchronization messaging feature to ensure the integrity of network synchronization during both normal and abnormal conditions. Through the use of synchronization messaging, the current quality of the timing source can be conveyed from one DDM-2000 OC-3/OC-12 Multiplexer to the next. This capability allows the DDM-2000 OC-3 and OC-12 Multiplexers to automatically change their timing reference in order to always maintain the highest quality timing available. The capability also allows the DDM-2000 OC-3 and OC-12 Multiplexers to inform a local BITS clock when the DS1 timing output has been degraded and should no longer be used as a reference. This synchronization messaging feature is based on the scheme developed in the *ANSI* T1X1 standards committee.

Applications

The applications that are currently supported with the synchronization messaging feature can be divided into three categories:

1. DS1 timing output integrity
2. Automatic synchronization reconfiguration
3. Synchronization provisioning integrity.

DS1 Timing Output Integrity

The derived DS1 timing outputs are typically used as a synchronization reference to a building integrated timing supply (BITS) clock which provides the timing reference to an externally-timed DDM-2000 OC-3/OC-12 Multiplexer. The synchronization reference is derived from the SONET transmission facility which is synchronized from an upstream timing reference. In this way, the timing from the BITS clock in one office (master) is distributed to the next office (slave) using the SONET transmission facilities between them as the synchronization vehicle. The BITS are typically capable of synchronizing to a stratum 3 or better accuracy. The DDM-2000 equipped with a TG3 is capable of synchronizing to a 4.6 ppm clock (stratum 3). The DDM-2000 equipped with a TGS is capable of synchronizing to a 20 ppm clock (between stratum 3 and stratum 4) or better. The stratum timing hierachy requires that clocks of equal or better stratum level be used to synchronize other clocks. In this way the stratum timing hierachy is preserved under all failure conditions. Under non-failure conditions, the DDM-2000 does not introduce its own internal timing source onto the SONET facility, but merely transfers the quality of its timing reference. A failure of all derived DS1 timing references to the BITS at the master office will cause the BITS to enter holdover mode, whose minimum accuracy is dependent on its internal clock. If the BITS internal clock is of equal or better stratum level than the DDM-2000, the externally-timed DDM-2000 will use this reference to synchronize all outgoing SONET transmission facilities. This preserves the required hierarchical structure of the timing network and should be maintained at all times.

If the externally-timed DDM-2000 at the master office enters holdover due to a disconnected reference cable or a local BITS failure, the quality of the derived DS1 timing output at the slave office will now be traceable directly to the DDM-2000. The stratum timing hierachy will be violated if the slave office BITS requires timing accuracy of better stratum level than that provided by the master DDM-2000’s internal clock. If the master DDM-2000 contains a TG3 circuit pack, stratum 3 accuracy will be maintained indefinitely. This provides acceptable timing for stratum 3 NEs at slave offices. If the master DDM-2000 contains a TGS circuit pack, and the slave office has a BITS of stratum 3 accuracy or better, stratum 3 accuracy will be maintained for the first 24 hours of holdover. After the first 24 hours of holdover, the DDM-2000 could exceed stratum 3 accuracy and cause the slave BITS to lose synchronization lock. Therefore, this configuration violates the stratum timing hierachy. Another scenario that will cause the stratum timing rules

to be violated is when at least one line-timed DDM-2000 exists at a site between the master and slave offices. In this scenario, a fiber cut between the master office and the line-timed site will cause the line-timed DDM-2000 to enter holdover (with accuracy dependent upon its internal clock). If the BITS at the slave office requires a higher accuracy clock than that generated by the DDM-2000 in holdover, the stratum timing hierachy will be violated.

As shown in Figure 6-17 (an OC-3 linear application used to explain the concepts of synchronization messaging), the use of SONET synchronization messaging notifies the DDM-2000 OC-3 Multiplexer at the slave site to place AIS on the DS1 timing output. This BITS can then enter holdover or switch to an alternate reference.

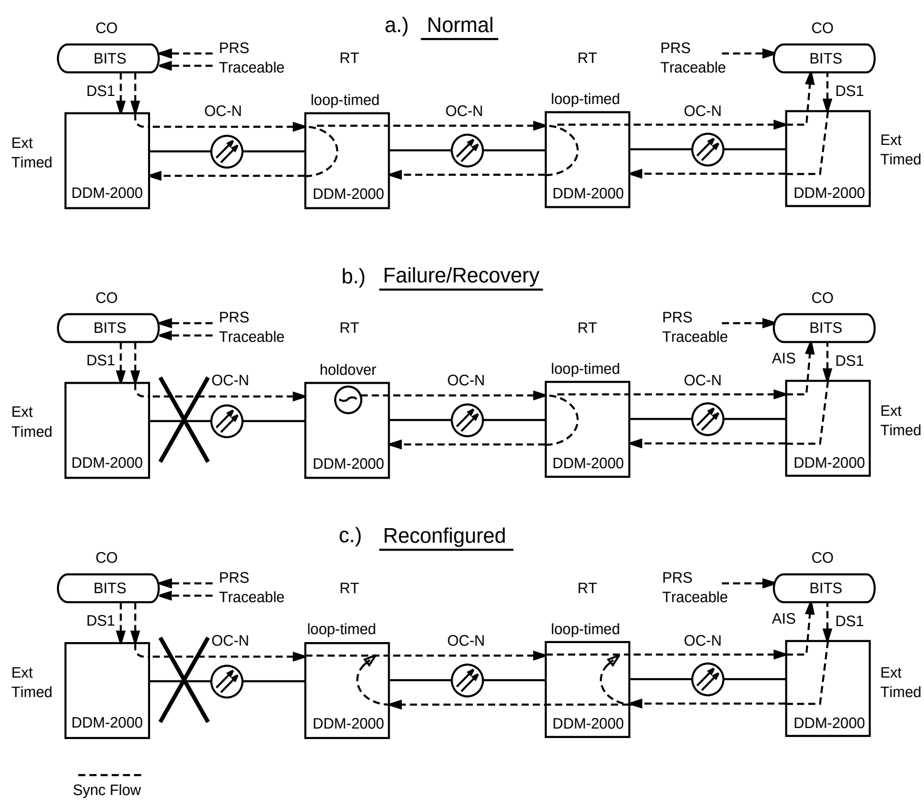


Figure 6-17. DS1 Timing Output — Dual Homing Linear

Automatic Synchronization Reconfiguration

SONET was designed to operate optimally in a synchronous environment. Although plesiochronous and asynchronous operation can be supported through the use of pointer adjustments, transmission quality is affected by the generation of additional jitter and wander due to pointer adjustments. Because of this, it is desirable to maintain synchronous operation whenever possible. Through the use of synchronization messages, the quality of the different timing references can be made available at each DDM-2000 OC-3/OC-12 Multiplexer. The DDM-2000 OC-3/OC-12 Multiplexer shelf can be optioned to determine the best timing reference available and switch to that reference. Through this mechanism, the synchronous operation of the subnetwork can be maintained. The switching of timing references is hitless, and the synchronization messages also allow it to be done without creating timing loops in the process.

In the linear dual-homing network in Figure 6-17c, normal operation includes an external timing reference at each of the COs. The RT sites are each line timed from the CO DDM-2000 OC-3 Multiplexers on the left. If a fiber failure occurs between the first two DDM-2000 OC-3 Multiplexers, the synchronization autoreconfiguration feature will cause the line timed DDM-2000 OC-3 Multiplexers to change their direction of line timing. This prevents any DDM-2000 OC-3 Multiplexer from operating in holdover for an extended period of time.

Consider the access ring network in Figure 6-18. Under normal operation, the ring has one DDM-2000 OC-3/OC-12 Multiplexer externally timed and the others line timed in the counterclockwise direction. If a fiber failure occurs between the first two DDM-2000 OC-3/OC-12 Multiplexers, the synchronization autoreconfiguration feature will cause the DDM-2000 OC-3/OC-12 Multiplexers to change their line timing directions to clockwise. The result is that the ring is again operating synchronously. The ring already provides self-healing of the traffic, so it is especially important to maintain synchronous operation during this type of failure to prevent service degradation due to increased jitter and wander.

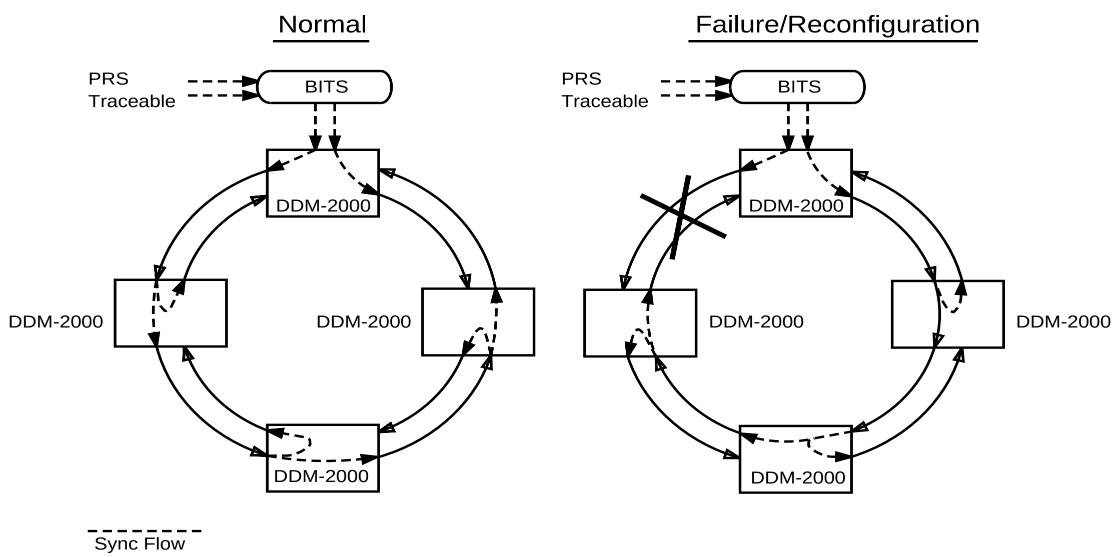


Figure 6-18. Synchronization Reconfiguration — Access Ring

Synchronization Provisioning Integrity

A welcome side feature of synchronization messaging is that it helps prevent provisioning errors. Provisioned timing loops on the DDM-2000 OC-3/OC-12 Multiplexers will be quickly detected through the synchronization messaging algorithm and prevented by forcing a shelf into holdover. The system can then be reprovisioned correctly.

Feature Details and Options

As mentioned previously, SONET synchronization messaging is used to communicate the quality of the subnetwork timing throughout the subnetwork. This is done using bits 1-3 of the K2 byte found in the SONET overhead. In OC-3 Release 9.1, OC-12 Release 5.1 and later releases, synchronization messaging can also be done using bits 5-8 of the S1 byte in the SONET overhead. If a DDM-2000 OC-3/OC-12 system is deriving timing from a given OC-N interface, and synchronization messaging is enabled on that interface (Kbyte messages, and Sbyte messages in OC-3 Release 9.1, OC-12 Release 5.1 and later, are provisioned using the **`set-ocn`** command), the system interprets the received message to determine its internal timing status. The system also determines the state of the DS1 output, if the DS1 output is enabled. The DDM-2000 OC-3/OC-12 system also transmits over the particular OC-N interface and all other OC-N interfaces that are enabled for synchronization messaging, the appropriate message indicating the quality of its timing and its active timing mode. Table 6-3 and Table 6-4 list the associated internal timing status and DS1 Output states that are associated with synchronization messages received from the OC-N interface when synchronization messaging is enabled. The tables lists the messages from low to high quality.

Table 6-3. Synchronization Messages using K2 Byte

Received Message	Active Timing Mode *	Default DS1 Output State	Quality Level
Don't Use	Holdover	AIS	7
Timing Looped Back (TLB)	Holdover	AIS	7
Stratum 4 †	Holdover	AIS	6
Internal Clock (IC)	OK to use	AIS	5
Internal Clock (IC) (w/TG3)	Holdover	AIS	5
Stratum 3 †‡	OK to use	Good	4
Stratum 2 †	OK to use	Good	3
Sync Quality Unknown (SQU)	OK to use	Good	2
Stratum 1 †	OK to use	Good	1

* This column applies only when provisioned for line timing mode.

† Presently, DDM-2000 OC-3/OC-12 Multiplexers cannot generate these messages, but they could be retransmitted and supported for autoreconfiguration if any of these are received by DDM-2000 OC-3/OC-12 Multiplexer.

‡ The TG3 circuit pack can generate a stratum 3 signal.

Table 6-4. Synchronization Messages using S1 Byte *

Received Message	Active Timing Mode †	Default DS1 Output State	Quality Level
Don't Use	Holdover	AIS	7
Traceable SONET Clock	OK to use	AIS	5
Traceable SONET Clock (w/TG3)	Holdover	AIS	5
Traceable Stratum 3 ‡§	OK to use	Good	4
Traceable Stratum 2 ‡	OK to use	Good	3
Sync Trace Unknown	OK to use	Good	2
PRS Traceable ‡	OK to use	Good	1

* This table is applicable to OC-3 R8.1, R9.1, OC-12 R5.1, and later releases.

† This column applies only when provisioned for line timing mode.

‡ Presently, DDM-2000 OC-3/OC-12 Multiplexers cannot generate these messages, but they could be retransmitted and supported for autoreconfiguration if any of these are received by DDM-2000 OC-3/OC-12 Multiplexer.

§ The TG3 circuit pack can generate a stratum 3 signal.

Synchronization messaging using the SONET K2 byte and S1 byte can be disabled on a per OC-N interface using the **`set-ocn`** command. Zeros will be transmitted on bits 1-3 of the K2 byte if this is done; all ones will be transmitted on bits 5-8 of the S1 byte if this is done. The timing and synchronization status of a shelf can be determined using the **`rtrv-sync`** command.

The "Don't use" message is sent when the system determines that its timing is not suitable for synchronization; for example, due to failure.

When the DDM-2000 OC-3/OC-12 system is configured for external timing and its DS1 output port is provisioned for MULT mode, the message Sync Quality Unknown (SQU) for K byte, or Sync Trace Unknown (STU) for S byte, is sent on all the OC-N interfaces where synchronization messaging is provisioned. When the capability of communicating with a BITS clock over the DS1 overhead exists, the quality of the reference signal will be transmitted instead; for example, stratum 1.

When the DDM-2000 OC-3/OC-12 system is configured for external timing and its DS1 output port is provisioned for SYNC OUT mode, the Timing Looped Back (TLB) message for K byte, or “Don’t Use” message for S byte, will be sent on the OC-N interfaces towards the NE from which the DS1 timing output is being derived. The SQU message for K byte, or STU for S byte, will be sent on all other OC-N interfaces where synchronization messaging is provisioned. If the DS1 output is generating AIS while the system is configured in this way, the message SQU for K byte, or STU for S byte, will be transmitted on all OC-N interfaces.

When using the TGS and the DDM-2000 OC-3/OC-12 system is configured for free run or is in holdover mode, the Internal Clock message for K byte, or Traceable SONET Clk for S byte, will be sent on all OC-3/OC-12 interfaces where synchronization messaging is provisioned. When using the TG3 and the DDM-2000 is configured for free run or is in holdover mode, the stratum 3 message for K byte, or Traceable stratum 3 for S byte, will be sent on all OC-3/OC-12 interfaces when synchronization messaging is provisioned.

When the DDM-2000 OC-3/OC-12 system is configured for line timing, the TLB message for K byte, and “Don’t Use” for S byte, will be sent on the OC-N interfaces towards the NE from which the timing is being derived. The message received on the OC-N interface will be sent on all other OC-N interfaces where synchronization messaging is provisioned.

With automatic synchronization reconfiguration (not supported in OC-12 linear applications), the DDM-2000 OC-3/OC-12 Multiplexer systems use and compare the incoming synchronization messages on the OC-N interfaces available for line timing to select the highest quality synchronization reference available. If the received quality levels are the same on the references available for timing, the existing line timing reference take precedence. This feature guarantees the non-revertive operation of reconfiguration. The line timing reference is provisioned by the **`set-sync`** command.

The existence of automatic synchronization reconfiguration does not change the system's behavior on traditional line failures; for example, LOF, LOP, LOS, and others.

There are synchronization references in the DDM-2000 OC-3/OC-12 system that can be provisioned as network timing sources but are not considered as timing sources for automatic synchronization reconfiguration. Examples of these are the linear extensions off of a DDM-2000 OC-3/OC-12 ring. This type of interface is considered a linear interface, and the system treats it as such with regards to synchronization.

Table 6-5 lists the synchronization references available on DDM-2000 OC-3 and OC-12 system topologies.

Table 6-5. Available Synchronization References

System	Manually Provisionable	Automatically Reconfigurable
OC-3 Linear	Main, Fn-C	Main, Fn-C
OC-3 Rings	Main-1, Main-2, Fn-C	Main-1, Main-2, Fn-C *
OC-12 Linear	Main-B	Not applicable
OC-12 Rings	Main-B-1, Main-B-2	Main-B-1, Main-B-2

* Release 9.0 and later ring releases.

In OC-3 Release 9.1, OC-12 Release 5.1, and later ring releases, the sending of DS1 AIS on the output of the BBF2B TGS circuit pack can be provisioned by using the **`set-sync`** command. Depending on the quality level of the incoming sync messages, this new parameter can be provisioned to send DS1 AIS upon receiving level 5 (default), level 4, level 3, or level 2. Refer to Table 6-3 and Table 6-4 for definitions of quality levels. AIS will be sent as long as the received message is at the provisioned or greater in quality level number.

In OC-3 Release 13.0, OC-12 Release 7.0, and later ring releases, the sending of DS1 AIS on the output of the BBF2B TGS and BBF4 TG3 circuit packs follow the same rules as outlined above.

Examples

In this part, some detailed examples are given to show specifically how the synchronization messages propagate through the DDM-2000 OC-3/OC-12 network and assist in the recovery from a fiber failure. Through these examples, one can extend the same concept to any other network that may include different topologies, number of sites, failure locations, and number of BITS clocks.

NOTE:
All nodes in a ring using automatic synchronization reconfiguration must have the synchronization messaging and automatic synchronization reconfiguration features enabled to prevent alarms.

In all of the following examples, if the sync message parameter within the **`set-oc3`** or **`set-oc12`** commands has been provisioned to “S byte” for an optical interface, then the equivalent S byte message will be transmitted from that optical interface. The following are equivalent messages:

K2: Sync Quality Unknown is the same as, S1: Sync Trace Unknown

K2: Timing Looped Back is the same as, S1: Don’t Use

K2: Internal Clock is the same as, S1: Traceable SONET Clock

K2: Stratum 3 is the same as, S1: Traceable Stratum 3.

Synchronization Reconfiguration Using an Externally Timed Access Ring

Figure 6-19 shows an externally timed access ring operating in its normal configuration. The DDM-2000 OC-3/OC-12 Multiplexer at the CO is externally timed from a BITS clock referenced to a Primary Reference Source (PRS). The remaining DDM-2000 OC-3/OC-12 Multiplexers are externally timed from a BITS referenced to a derived DS1. The SQU message is sent to indicate where timing is traceable to an external BITS and where it is valid to be used. Automatic synchronization reconfiguration is not an option for externally timed DDM-2000 OC-3/OC-12 Multiplexers. Therefore, a change in the synchronization message will not cause an automatic synchronization reconfiguration.

a) Synchronization Reconfiguration Example (Before Failure)

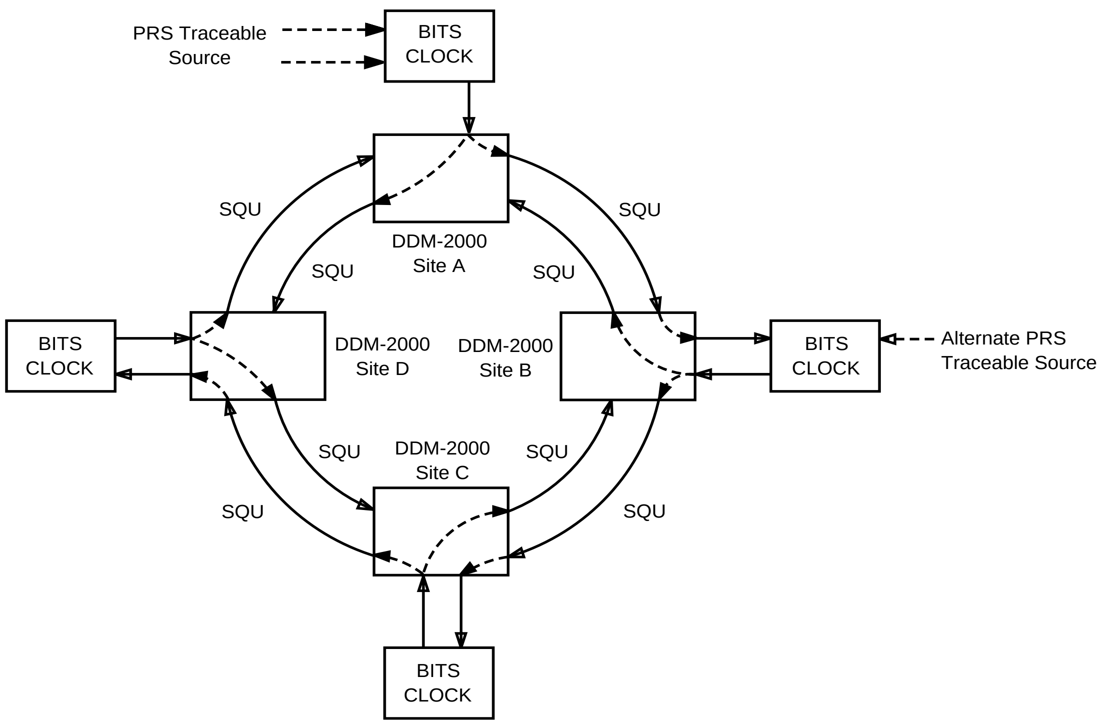


Figure 6-19. Synchronization Reconfiguration — Externally Timed Access Ring (Sheet 1 of 2)

In Figure 6-19, a fiber has been cut between sites A and B. Immediately the DDM-2000 OC-3/OC-12 Multiplexer at site B changes the format of its derived DS1 to AIS. This forces the BITS clock at site B to enter holdover or switch input source (if a valid one is available). Because automatic synchronization reconfiguration is not available, the synchronization status messages are not used. All other non-host nodes will track the holdover clock at site B. Although no timing loops have been formed, the timing of all non-host nodes will differ from the host node by the accuracy of the holdover clock at site B.

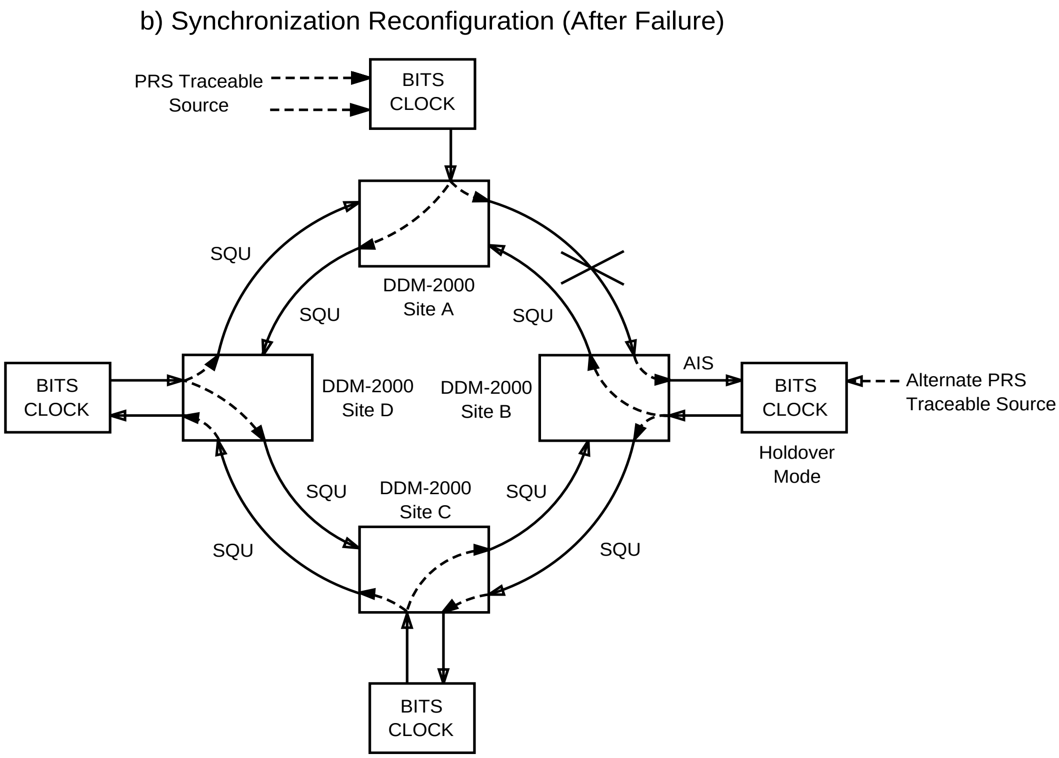
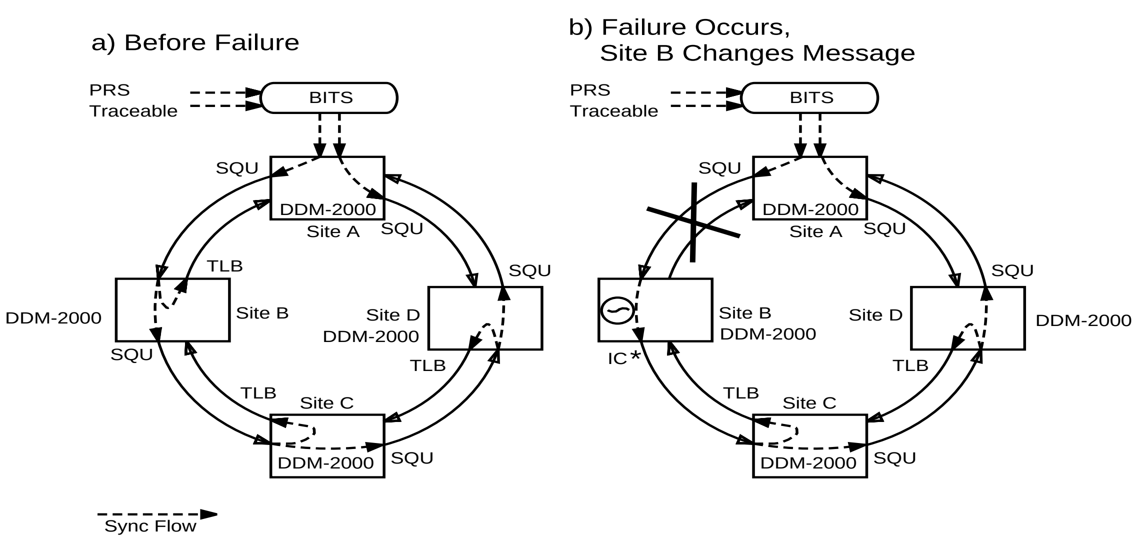


Figure 6-19. Synchronization Reconfiguration — Externally Timed Access Ring (Sheet 2 of 2)

Synchronization Reconfiguration in an Access Ring

Figure 6-20a shows the access ring operating in its normal configuration. The DDM-2000 OC-3/OC-12 Multiplexer at the CO is externally timed, and each of the other DDM-2000 OC-3/OC-12 Multiplexers are line timed in a counterclockwise direction. The SQU message is sent to indicate where timing is traceable to an external BITS and where it is valid to be used. The TLB message is sent on the interface that is being used as the line timing reference and, thus, where using that timing would create a timing loop. Synchronization messaging and automatic synchronization have both been enabled for this network.

In Figure 6-20b, a fiber has been cut between sites A and B. Immediately, the DDM-2000 OC-3/OC-12 Multiplexer at site B enters holdover and sends out the internal clock (IC) message if using a TGS, or STRATUM 3 message if using a TG3, to site C. The DDM-2000 OC-3/OC-12 Multiplexer at site B cannot switch to line time from site C because it is receiving the TLB message on that interface.

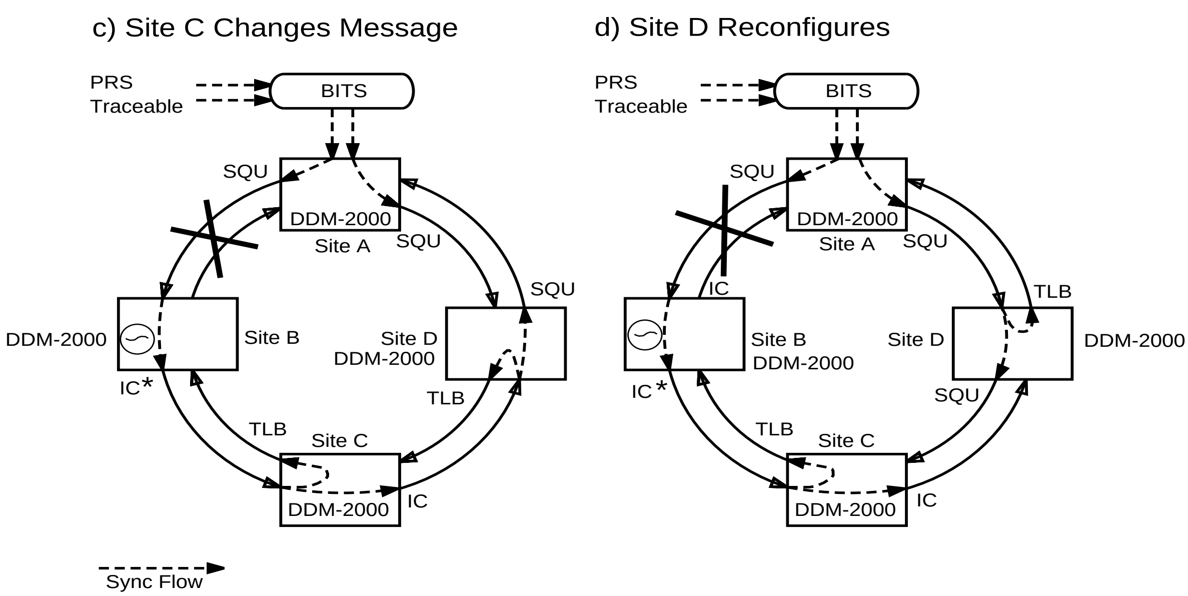


*STRATUM 3 if using a TG3 at site B, or IC if using a TGS.

Figure 6-20. Synchronization Reconfiguration — Access Ring (Sheet 1 of 3)

In Figure 6-20c, the DDM-2000 OC-3/OC-12 Multiplexer at site C detects the incoming IC message and sends out the IC message to site D. The DDM-2000 OC-3/OC-12 Multiplexer at site C cannot switch to line time from the other rotation because it is receiving the TLB message on that interface.

In Figure 6-20d, the DDM-2000 OC-3/OC-12 Multiplexer at site D detects the incoming IC or STRATUM 3 message. Because this DDM-2000 OC-3/OC-12 Multiplexer is receiving the SQU message from site A, it will switch to line time from site A because SQU is higher quality than IC or STRATUM 3. After the switch occurs, the TLB message is sent back to site A and the SQU message is retransmitted to site C.

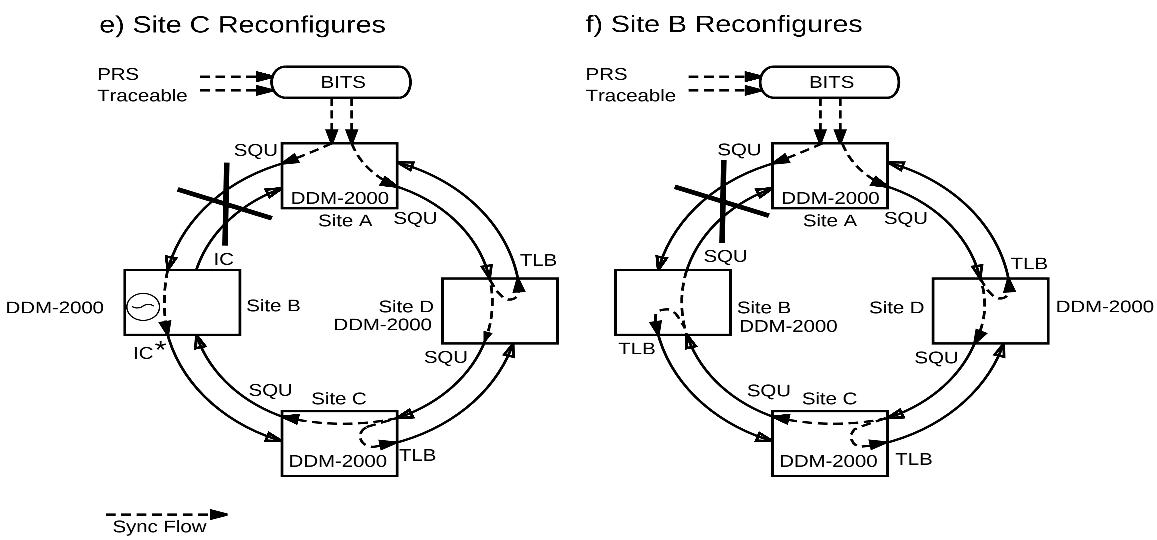


* STRATUM 3 if using a TG3 at Site B, or IC if using a TGS.

Figure 6-20. Synchronization Reconfiguration — Access Ring (Sheet 2 of 3)

In Figure 6-20e, the DDM-2000 OC-3/OC-12 Multiplexer at site C detects the incoming SQU message from site D. The SQU message is a better quality message than the IC or STRATUM 3 message being received from site B, so the DDM-2000 OC-3/OC-12 Multiplexer at site C switches to line time from site D. After the switch occurs, the TLB message is sent back to site D, and the SQU message is retransmitted to site B.

In Figure 6-20f, the DDM-2000 OC-3/OC-12 Multiplexer at site B detects the incoming SQU message from site C. The SQU message is a better quality message than the internal holdover capability, so the DDM-2000 OC-3/OC-12 Multiplexer at site B switches to line time from site C. After the switch occurs, the TLB message is sent back to site C, and the SQU message is forwarded to site A. When the failure clears, the synchronization remains in the new configuration unless it is manually switched back.



*STRATUM 3 if using a TG3 at site B, or IC if using a TGS.

Figure 6-20. Synchronization Reconfiguration — Access Ring (Sheet 3 of 3)

Synchronization Messaging to Support DS1 Timing Outputs

Figure 6-21a (an OC-3 liner application used to explain the concepts of synchronization messaging) shows a dual homing linear network operating in its normal configuration. The DDM-2000 OC-3 Multiplexer at site A is externally timed, and the DDM-2000 OC-3 Multiplexers at sites B and C are line timed from site A. The DDM-2000 OC-3 Multiplexer at site D is also externally timed from another BITS. Both BITS should be PRS traceable. The SQU message is sent to indicate where timing is traceable to an external BITS and where it is valid to be used. The TLB message is sent to indicate where line timing has been used, and thus, where using that timing would create a timing loop. Synchronization messaging has been enabled for this network but automatic synchronization reconfiguration has not been enabled.

In Figure 6-21b, a fiber has been cut between sites A and B. Immediately, the DDM-2000 OC-3 Multiplexer at site B enters holdover and sends out the IC message to site C.

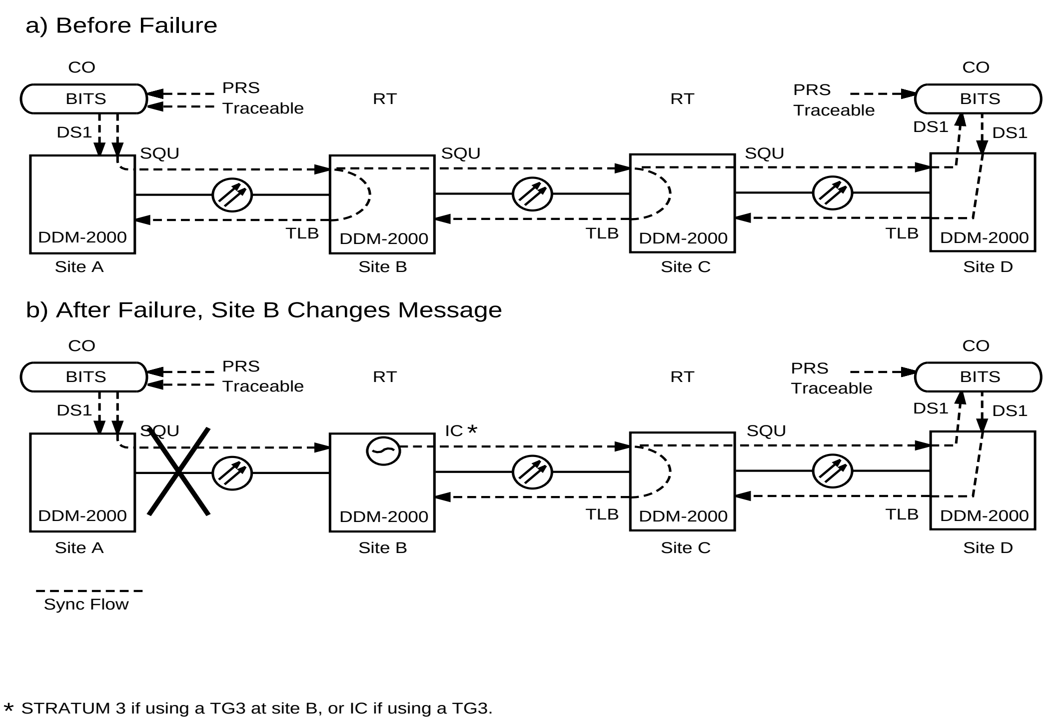


Figure 6-21. DS1 Timing Output with Fiber Failure — (Sheet 1 of 2)

In Figure 6-21c, the DDM-2000 OC-3 Multiplexer at site C detects the incoming IC message from site B and forwards it on to site D.

In Figure 6-21d, the DDM-2000 OC-3 Multiplexer at site D detects the incoming IC or STRATUM 3 message from site C and sends out AIS to the BITS. The BITS will enter switch to an alternate reference, if available, or enter holdover.

If the automatic synchronization reconfiguration feature had been enabled in this example, at this point, sites C and B would attempt to switch line timing directions to retime from site D.

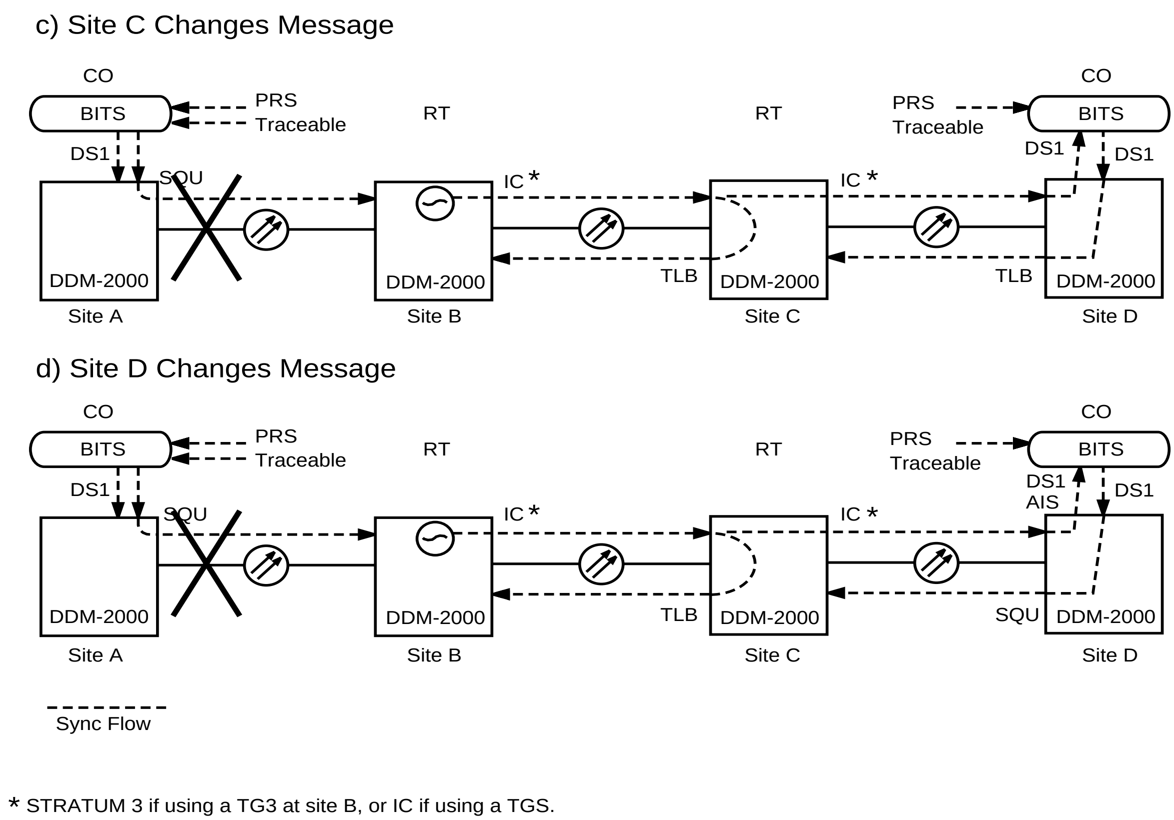


Figure 6-21. DS1 Timing Output with Fiber Failure — (Sheet 2 of 2)

OC-12 Regenerator Synchronization

OC-12 Regenerators are through-timed (timing is recovered from the signal incoming to each OC-12 Regenerator and used to retime the outgoing signal). External timing references BBF2B or BBF4 circuit packs are not allowed in OC-12 Regenerator shelves. Synchronization protection switching or holdover is not required since the loss of incoming signal means the loss of data, as well as timing.

Network Timing Distribution Questions

The following are some frequently asked questions about network timing distribution with DDM-2000 OC-3 and OC-12 Multiplexers.

Network Timing Distribution with DDM-2000 OC-3 and OC-12 Multiplexers

Frequently Asked Questions and Answers

1. Question: How do I time DDM-2000 OC-3/OC-12 shelves in a central office environment?

   Answer: Each DDM-2000 OC-3/OC-12 should be externally referenced to the BITS clock in the office. If a BITS clock is not available in the office, a traffic-carrying DS1 from the local switch may be bridged (for example, using a bridging repeater) as the reference to the DDM-2000 OC-3/OC-12. Line/loop timing the DDM-2000 OC-3/OC-12 may also be used, but at least one DDM-2000 OC-3/OC-12 in the network must be externally timed.

2. Question: Where do I use the DS1 timing output feature?

   Answer: The primary application is for supplying a timing reference to the office BITS clock. This allows the BITS clock to be slaved to a BITS clock in another office that is, in turn, traceable to the primary reference source (PRS). Typically, the DDM-2000 OC-3/OC-12 supplying the DS1 timing output will, in turn, be externally timed by the BITS clock. If there is no BITS clock, the DS1 timing output can be used to time a switch or switch remote (if the switch remote is equipped for that option) directly or even another DDM-2000 OC-3/ OC-12 Multiplexer.

3. Question: How do I prevent my BITS clock from using a DS1 timing output when a failure in the network results in this DS1 being timed from a SONET network element (NE) in holdover?

   Answer: SONET synchronization messaging informs the local DDM-2000 OC-3/OC-12 of this condition, and AIS is inserted on the DS1 timing output.

4. Question: What is the advantage of using the DS1 timing output instead of a multiplexed DS1 as the timing reference?

   Answer: The DS1 timing output is derived from the optical line rate and is superior because:

   - **The DS1 is virtually jitter-free**
   - **Synchronization messages guarantee the traceability of the timing**
   - **Administration of traffic DS1s for timing is eliminated.**

5. Question: Can I ever use the DDM-2000 OC-3/OC-12 in the free running timing mode?

   Answer: If a PRS traceable external reference is available, it is the recommended timing mode for any/all CO applications. The free running timing mode can be used but a slight increase in jitter will result. If one DDM-2000 OC-3/OC-12 is provisioned for free running, all other DDM-2000 OC-3/OC-12s in the network must be line/loop timed and SONET interfaces to other equipment are not allowed. The DS1 timing output is not allowed with a free running network.

6. Question: How do I provide timing to a central office host switch that does not have the option for an external reference?

   Answer: A DS1 carried over SONET may contain significant jitter/wander and be unacceptable to the switch as a timing reference. If the central office has a BITS clock, the recommendation is to use the output from the BITS clock into an unused DS1 traffic port on the switch. If the central office does not have a BITS clock, the recommendation is to use the DS1 timing output from the DDM-2000 OC-3/OC-12 as the line/loop timing reference into an unused DS1 traffic port on the switch.

7. Question: Can a DS1 carried over SONET ever be used as a timing reference?

   Answer: Yes! In many applications there is no other choice. Most switch remotes, for instance, obtain their timing from a specific DS1 signal generated by their host switch; so these remotes must line/loop time from the DS1 signal. In addition, DLC equipment, channel banks, and PBXs will not likely have external references and may be allowed to line/loop time from a DS1 carried over SONET.

8. Question: Are there any specific concerns when using a DS1 carried over SONET to time equipment such as a switch remote or DLC?

   Answer: Yes. The major concern is to make sure all the equipment is synchronous. The DDM-2000 OC-3/OC-12s should be synchronous to each other to prevent pointer adjustments. This can be accomplished by having one source DDM-2000 OC-3/OC-12 that is externally timed. The other DDM-2000 OC-3/OC-12s in the network should be line/loop timed, or they should be externally timed to a clock to which they provide a DS1 timing output. The DDM-2000 OC-3/OC-12s should also be synchronous to the switch to prevent excessive mapping jitter. This can be done by synchronizing the host switch to the BITS clock used to reference the DDM-2000 OC-3/OC-12.

9. Question: Will I have any problems providing timing to a customer that has a high quality PBX or switch?

   Answer: If the network is completely synchronous, as described in the previous answer, there should be no problems. If the PBX is sensitive to the jitter produced, even under the synchronous conditions, the DS1 timing output of DDM-2000 OC-3/OC-12 may be required to be used as a timing reference to this equipment.

10. Question: Why does Telcordia Technologies say that DS1s carried over SONET should not be used for timing?

    Answer: Because there are several limitations, as discussed previously, Telcordia Technologies has provided this recommendation. Telcordia Technologies says that DS1s carried over SONET must be used in applications such as switch remotes and will be acceptable, provided pointer adjustments are not created.

11. Question: Can pointer adjustments be prevented?

    Answer: Neither random nor periodic pointer adjustments will occur if the DDM-2000 OC-3/OC-12 shelf is provisioned for line/loop timing.

12. Question: How do I time DDM-2000 OC-3/OC-12 at a remote site?

    Answer: Line/loop time.

13. Question: How many DDM-2000 OC-3/OC-12s can I chain together in an add/drop configuration before the timing becomes degraded?

    Answer: The stratum level traceability of the nth node in an add/drop chain is the same as that in the first node. Also, while timing jitter will theoretically increase as the number of nodes is increased, the high quality timing recovery and filtering on the DDM-2000 OC-3/OC-12 allows add/drop chains to be extended to any practical network limit without detectable increases in jitter levels. In practice, the only effects on timing at the nth node will occur whenever high-speed protection switches occur in any of the previous n-1 nodes. These effects should be rare.

14. Question: How do I time a DDM-2000 OC-3/OC-12 ring network?

    Answer: An interoffice ring should have each node externally timed if BITS clocks are available. All other rings should have one node externally timed (two in some dual homing architectures) and the rest of the nodes line timed. In Release 5 of OC-3, a command allows the direction of line timing synchronization to be switched if a failure occurs. Release 7 of OC-3 and Release 3 of OC-12 allows this synchronization reconfiguration to become automatic.

15. Question: Why are there more issues related to timing with SONET equipment than there is with asynchronous equipment?

    Answer: SONET equipment was designed to work ideally in a synchronous network. When the network is not synchronous, mechanisms such as pointer processing and bit-stuffing must be used and jitter/wander increases.

16. Question: Can DS3 signals be used to carry DS1 timing signals without the worry of having the network synchronous?

    Answer: Yes, although this option may be more expensive.

17. Question: What are the limitations on automatic synchronization reconfiguration?

    Answer: Automatic synchronization reconfiguration is only available when the DDM-2000 OC-3/OC-12 is provisioned for line timing mode. This allows the timing direction of an OC-N ring or linear network to change automatically in response to a failure. When the DDM-2000 OC-3/OC-12 is provisioned for external timing, automatic synchronization reconfiguration is not available. When an OC-N fault is detected in the timing direction, AIS is inserted on the derived DS1s which forces the BITS into holdover preventing timing loops.

18. Question: How do I synchronize a BITS clock and maintain automatic synchronization reconfiguration on a DDM-2000 OC-3/OC-12 ring?

    Answer: Provision all but the host node (node with a co-located PRS) for line timing. Provide each non-host BITS clock with a pair of derived DS1s. The DDM-2000 OC-3/OC-12 will detect faults and provide the BITS clocks with good inputs if available. Timing loops will be prevented. The host node should be set for external timing and get its timing from an externally timed BITS clock. To prevent a timing loop, the host BITS clock should get its timing from a PRS traceable source. The non-host nodes should not be timed from the co-located BITS clock since this would disable the automatic synchronization reconfiguration feature.

19. Question: When do I use a TG3 circuit pack?

    Answer: TG3 circuit packs are used when applications require a stratum 3 frequency stability of ± 4.6 ppm or better. Such applications include stand-alone networks requiring a stratum 3 free-running frequency source. Other TG3 applications include critical service applications where payload errors due to frequency offsets can not be tolerated. Stratum 3 clock stability limits the frequency drift to a maximum of ± .37 ppm over 24 hours.

Cross-Connect Provisioning

The basic type of cross-connection allows a low-speed channel to be cross-connected to a channel in the high speed interface portion of the shelf. This is used in all linear add/drop applications where DS1, DS3, VT1.5, STS-1, EC-1, and STS-3c low-speed signals are cross-connected to VT1.5, STS-1 or STS-3c channels in the high-speed linear interfaces.

The next type of cross-connection allows a low-speed channel to be cross-connected to a channel in the high-speed ring interface. This is used in all path switched ring applications where DS1, DS3, VT1.5, STS-1, EC-1, and STS-3c low-speed signals are cross-connected to VT1.5, STS-1, or STS-3c channels in both rotations of the rings terminating on the high-speed interfaces. With this cross-connection, all added signals are bridged on to both rotations of the ring, and the better of the two signals received from the two rotations of the ring is dropped.

Another type of cross-connection allows a high-speed VT1.5, STS-1, or STS-3c channel to be "passed-through" between two high-speed ring interfaces. This is used in all path switched ring applications at nodes where traffic is not dropped. In path switched rings, pass-through grooming (passing a signal on a ring time slot that is different from the ring time slot on which it was received) is not supported.

End-to-end survivable service facilities need to cross multiple rings interconnected at multiple wire centers. To support these applications, a drop-and-continue cross-connection is provided for a signal from a high-speed channel to be dropped to a specified low-speed channel and continued on to the next node in the same direction while also adding a corresponding signal from the low-speed channel to the high-speed channel in the other rotation of the ring.

A variation of ring cross-connections, the "locked cross-connection," is supported at the VT1.5 level to lock the path selector to a specified rotation of the ring. This is used where an external path selector is used. In this cross-connection, a DS1 signal from the low-speed interface is cross-connected to the specified VT1.5 channel in the high-speed interface in the specified direction, and any signal received in the VT1.5 channel from the other rotation of the ring is ignored.

Another variation of ring cross-connections, the "DS3 0x1 cross-connection," is supported at the STS-1 level to lock the path selector to a specified rotation of the ring. This is used where an external path selector is used. In this cross-connection, an STS-1 signal from the high-speed interface is cross-connected to the specified function group in the high-speed interface and any signal received in the STS-1 channel from the other rotation of the ring is ignored.

In order to support unprotected video broadcast services on OC-12 systems, two additional cross-connection types are provided. One is used to add two unprotected STS-3c formatted video signals simultaneously but independently to the STS-3c channels in the two rotations of the ring. The other is used to drop two unprotected STS-3c formatted video signals from the two rotations of the ring simultaneously but independently to the STS-3c channels in the OC-3 low-speed interface.

"Hairpin" cross-connections allow local drop of signals, ring extensions supported by a ring host node, and allow passing traffic between two ring interfaces on a single host node. In this case, no high speed channel is involved and the cross-connections are entirely within the interfaces in the Function Units.

In DDM-2000 OC-3 Release 9 and later, VT1.5 signals from function Units A or B can be cross-connected to VT1.5 signals in Function Unit C. The VT1.5 signals can be in any MXRVO, STS1E, and 22-type OLIU, with the exception that MXRVO-to-MXRVO hairpins are not allowed. The available interfaces are:

- DS1 to EC-1/OC-3
- EC-1 to OC-3
- EC-1 to EC-1
- OC-3 to OC-3.

Table 6-6 lists the number of available VT1.5 cross-connections including hairpin cross-connections:

Table 6-6. DDM-2000 OC-3 Available VT1.5 Cross-Connections, Including Hairpin

Slot	Main	Fn-A	Fn-B	Fn-C
Main	336	56	56	84
Fn-A	56	0	0	56 *
Fn-B	56	0	0	56 *
Fn-C	84	56 *	56 *	0

* Hairpin cross-connections.

Cross-Connect Types

The following list defines the cross-connect types listed in Table 6-7 through Table 6-12. These tables list allowable cross-connects as determined by circuit pack type, location and software release.

- **Two-Way**: A two-way cross-connection between two non-ring interfaces is a bidirectional cross-connection between two ports, two channels, or one port and one channel. This type of cross-connection can be used in both “linear” and “ring” generics; when used in a “ring” generic, it is sometimes referred to as a “hairpin” cross-connection.
- **Add/Drop**: A two-way cross-connection add/drop to/from a ring interface is a bidirectional cross-connection between a channel on a path-protection switched ring and a port or channel on a non-ring interface.
- **Dual 0x1**: A two-way dual 0x1 cross-connection between two ring interfaces is a bidirectional cross-connection between channels on each of two different ring interfaces.
- **Intra-FN Dual 0x1**: A two-way intra-FN dual 0x1 cross-connection between two ring interfaces is a bidirectional cross-connection between channels on the two different ring interfaces supported by a pair of dual-port OLIUs in the same function unit.
- **Dual 0x1 NR**: A two-way dual 0x1 cross-connection between a ring interface and a non-ring interface is a bidirectional cross-connection between a channel on a ring interface and a port on a non-ring interface.
- **Pass-Through**: A two-way pass-through cross-connection on a ring interface is a bidirectional cross-connection on a single ring interface.
- **Single 0x1**: A two-way single 0x1 ring to ring cross-connection is a bidirectional cross-connection between channels on each of two different ring interfaces. This type of cross-connection is used in “dual homing” network configurations.
- **Intra-FN Single 0x1**: A two-way intra-FN single 0x1 ring to ring cross-connection is a bidirectional cross-connection between channels on the two different ring interfaces supported by a pair of dual-port OLIUs in the same function unit. This type of cross-connection is used in “dual homing” network configurations.
- **Single 0x1 NR**: A two-way single 0x1 cross-connection between a ring interface and a non-ring interface is a bidirectional cross-connection between a channel on a ring interface and a port on a non-ring interface.
- **Drop/Continue**: A drop and continue cross-connection between a ring and an non-ring interface is a bidirectional cross-connection.
- **Unprotected Video Broadcast**: An unprotected video broadcast source cross-connection on a ring interface is an asymmetric bidirectional cross-connection from a broadcast source onto an OC-N ring.

- **Protected Broadband Services**: A protected broadband source cross-connection on a ring is a symmetric bidirectional cross-connection from a broadband source onto an OC-N ring.
- **Locked VT**: A ring (0x1) VT locked cross-connection between low-speed and high-speed time slots, locking ring traffic onto a designated ring rotation.

Allowable Cross-Connects

Table 6-7 through Table 6-12 indicate the earliest release of software for the cross-connect types listed.

Table 6-7. DDM-2000 OC-3 Ring Cross-Connect Types Allowable (Main to Main)

From MAIN		To MAIN			
Circuit Pack	**Cross Connect Type**	**22-type**	**24-type**	**27-type**	**29-type**
22-type	Pass-Through STS	5.1			
	Pass-Through VT	5.0			
	Drop/Continue STS	7.0			
	Drop/Continue VT	7.0*			
24-type	Pass-Through STS		11.0		
	Pass-Through STS-3C		11.0		
	Pass-Through VT		11.0		
	Drop/Continue STS		11.0		
	Drop/Continue VT		11.0		
27-type	Pass-Through STS			9.0	
	Pass-Through VT			9.0	
	Drop/Continue STS			9.0	
	Drop/Continue VT			9.0*	
29-type	Pass-Through STS				15.0
	Pass-Through STS-3C				15.0
	Pass-Through VT				15.0
	Drop/Continue STS				15.0
	Drop/Continue VT				15.0

* All VT1.5 drop and continue cross-connections in a system must be in the same direction, i.e. from the same ring (m1 or m2).

Table 6-8. DDM-2000 OC-3 Ring Cross-Connect Types Allowable (Main to Function Unit)

From MAIN		To FUNCTION UNIT								
Circuit Pack	Cross-Connect Type	22-type*	26G2-U	27G-U	27G2-U	DS3	STS1E†	MXRVO	TMUX	LAN
22-type	Add/Drop STS	7.0‡ 9.0§				5.1 ¶	5.1	5.1	13.0, 11.1	
	Add/Drop VT	7.0‡ 9.0§					5.1	5.0	13.0, 11.1	15.0
	Dual 0x1 STS	15.0	13.0, 11.1 §§	9.0	9.0 ¶¶					
	Dual 0x1 VT	15.0	13.0, 11.1 §§	9.0	9.0 ¶¶					
	Dual 0x1 NR STS					11.0**				
	Single 0x1 STS	15.0	13.0, 11.1 ††§§	9.0 ††	9.0 ††¶¶					
	Single 0x1 VT	15.0	13.0, 11.1 ††§§	9.0 ††	9.0 ††¶¶					
	Single 0x1 NR STS					11.0				
	Drop/Continue STS	7.2					7.0			
	Drop/Continue VT	7.2 ‡‡					7.0 ‡‡			
	Locked VT							9.0	13.0, 11.1	15.0
	Dual 0x1 NR STS									

From MAIN		To FUNCTION UNIT								
Circuit Pack	**Cross-Connect Type**	**22-type[*]**	**26G2-U**	**27G-U**	**27G2-U**	**DS3**	**STS1E[†]**	**MXRVO**	**TMUX**	**LAN**
27-type	Add/Drop STS	9.0				9.0 ¶	9.0	9.0	13.0, 11.1	
	Add/Drop VT	9.0					9.0	9.0	13.0, 11.1	15.0
	Dual 0x1 STS	15.0	13.0, 11.1	9.0	9.0					
	Dual 0x1 VT	15.0	13.0, 11.1	9.0	9.0					
	Dual 0x1 NR STS					11.0 **				
	Single 0x1 STS	15.0	13.0, 11.1 ††	9.0 ††	9.0 ††					
	Single 0x1 VT	15.0	13.0, 11.1 ††	9.0 ††	9.0 ††					
	Single 0x1 NR STS					11.0 **				
	Drop/Continue STS	9.0				9.0 ¶	9.0			
	Drop/Continue VT	9.0 ‡‡					9.0 ‡‡			
	Locked VT							9.0	13.0, 11.1	15.0
	Dual Locked STS									

From MAIN		To FUNCTION UNIT								
Circuit Pack	**Cross-Connect Type**	**22-type***	**26G2-U**	**27G-U**	**27G2-U**	**DS3**	**STS1E†**	**MXRVO**	**TMUX**	**LAN**
24-type	Add/Drop STS	11.0				11.0	11.0	11.0	13.0, 11.1	
	Add/Drop VT	11.0					11.0	11.0	13.0, 11.1	15.0
	Dual 0x1 STS	15.0	13.0, 11.1 §§	11.0	11.0 ¶¶					
	Dual 0x1 VT	15.0	13.0, 11.1 §§	11.0	11.0 ¶¶					
	Dual 0x1 NR STS					11.0				
	Single 0x1 STS***	15.0	13.0, 11.1 §§	11.0	11.0 ¶¶					
	Single 0x1 VT***	15.0	13.0, 11.1 §§	11.0	11.0 ¶¶					
	Single 0x1 NR STS					11.0				
	Drop/Continue STS	11.0					11.0			
	Drop/Continue VT	11.0					11.0			
	Locked VT							11.0	13.0, 11.1	15.0
	Dual Locked STS									

From MAIN		To FUNCTION UNIT								
Circuit Pack	Cross-Connect Type	22-type*	26G2-U	27G-U	27G2-U	DS3	STS1E†	MXRVO	TMUX	LAN
29-type	Add/Drop STS	15.0				15.0	15.0	15.0	15.0	
	Add/Drop VT	15.0					15.0	15.0	15.0	15.0
	Dual 0x1 STS	15.0	15.0 §§	15.0	15.0 ¶¶					
	Dual 0x1 VT	15.0	15.0 §§	15.0	15.0 ¶¶					
	Dual 0x1 NR STS					15.0				
	Single 0x1 STS***	15.0	15.0 §§	15.0	15.0 ¶¶					
	Single 0x1 VT***	15.0	15.0 §§	15.0	15.0 ¶¶					
	Single 0x1 NR STS					15.0				
	Drop/Continue STS	15.0					15.0			
	Drop/Continue VT	15.0					15.0			
	Locked VT							15.0	15.0	15.0
	Unprotected STS-3C	15.0								

* A 22-type OLIU in a function unit is in “linear” (1+1 line protected or unprotected) R15, not a ring 0x1 configuration.

† This table refers to only “low-speed” STS-1 interfaces.

‡ Only FN-B and/or FN-C can be equipped with 22-type OLIUs in this release.

§ FN-A, FN-B and/or FN-C can be equipped with 22-type OLIUs in this release.

¶ This entry valid for DS3 circuit packs except the BBG19 front-access pack.

** This entry valid for the BBG19 front-access DS3 circuit pack.

†† One of the pair of function unit slots will be empty.

‡‡ All VT1.5 drop and continue cross-connections in a system must be in the same direction, i.e. from the same ring (m1 or m2).

§§ The mixing of 0x1, Pass-Through, and local Add/Drop cross-connects is supported beginning with R13.0.

¶¶ The mixing of 0x1, Pass-Through, and local Add/Drop cross-connects is supported beginning with R11.0.

*** 0x1 is an unprotected ring interface.

Table 6-9. DDM-2000 OC-3 Ring Cross-Connect Types Allowable (Function Unit to Function Unit)

From FUNCTION UNIT		To FUNCTION UNIT						
Circuit Pack	**Cross-Connect Type**	**22-type***	**26G2-U**	**27G2-U**	**DS3**	**STS1E†**	**MXRVO**	**TMUX**
22-type	Two-Way STS	15.0, 13.0, 11.1			15.0, 13.0, 11.1	15.0, 13.0, 11.1		
	Two-Way VT	9.0				9.0	9.0	15.0, 13.0, 11.1
	Add/Drop STS		15.0, 13.0, 11.1	11.0				
	Add/Drop VT		15.0, 13.0, 11.1	11.0				
26G2-U	Add/Drop STS	15.0, 13.0, 11.1 ‡‡				15.0, 13.0, 11.1	15.0, 13.0, 11.1 §‡‡	15.0, 13.0, 11.1
	Add/Drop VT	15.0, 13.0, 11.1 ‡‡	15.0, 13.0, 11.1 ‡,‡‡			15.0, 13.0, 11.1	15.0, 13.0, 11.1 §‡‡	15.0, 13.0, 11.1
	Dual 0x1 STS		15.0, 13.0, 11.1 ¶‡‡	15.0, 13.0, 11.1 ¶‡‡				
	Dual 0x1 VT		15.0, 13.0, 11.1 ¶‡‡	15.0, 13.0, 11.1 ¶‡‡				
	Pass-Through STS		15.0, 13.0, 11.1 ‡‡					
	Pass-Through VT		15.0, 13.0, 11.1 ‡‡					
	Single 0x1 STS		15.0, 13.0, 11.1 ¶**‡‡	15.0, 13.0, 11.1 ¶**‡‡				
	Single 0x1 VT		15.0, 13.0, 11.1 ¶**‡‡	15.0, 13.0, 11.1 ¶**‡‡				

From FUNCTION UNIT		To FUNCTION UNIT						
Circuit Pack	**Cross-Connect Type**	**22-type[*]**	**26G2-U**	**27G2-U**	**DS3**	**STS1E[†]**	**MXRVO**	**TMUX**
27G2-U	Add/Drop STS	11.0 §§				11.0	11.0 §§	15.0, 13.0, 11.1
	Add/Drop VT	11.0 §§				11.0	11.0 §§	15.0, 13.0, 11.1
	Dual 0x1 STS		15.0, 13.0, 11.1 ¶§§	9.1 ¶§§				
	Dual 0x1 VT		15.0, 13.0, 11.1 ¶§§	9.1 ¶§§				
	Intra-FN Dual 0x1 VT			9.1 ††				
	Pass-Through STS			9.1 §§				
	Pass-Through VT			9.1 §§				
	Single 0x1 STS		15.0, 13.0, 11.1 ¶**§§	9.1 ¶**§§				
	Single 0x1 VT		15.0, 13.0, 11.1 ¶**§§	9.1 ¶**§§				
	Intra-FN Single 0x1VT			9.1 ††**				
STS1E	Two-Way VT	9.0				9.0	9.0	15.0, 13.0, 11.1
	Two-Way STS	15.0, 13.0, 11.1			15.0, 13.0, 11.1	15.0, 13.0, 11.1		
	Add/Drop STS		15.0, 13.0, 11.1	11.0				
	Add/Drop VT		15.0, 13.0, 11.1	11.0				

From FUNCTION UNIT		To FUNCTION UNIT						
Circuit Pack	Cross-Connect Type	22-type*	26G2-U	27G2-U	DS3	STS1E†	MXRVO	TMUX
MXRVO	Two-Way VT	9.0				9.0		
	Add/Drop STS		15.0, 13.0, 11.1 §‡‡	11.0 §§				
	Add/Drop VT		15.0, 13.0, 11.1 §‡‡	11.0 §§				
TMUX	Two-Way VT	15.0, 13.0, 11.1				15.0, 13.0, 11.1		
	Add/Drop STS		15.0, 13.0, 11.1 §	15.0, 13.0, 11.1				
	Add/Drop VT		15.0, 13.0, 11.1 §	15.0, 13.0, 11.1				

* A 22-type OLIU in a function unit is in "linear" (unprotected or 1+1 line protected), not a ring configuration.

† This table refers to only "low-speed" STS-1 interfaces.

‡ This entry represents the hairpin local drop cross-connection between a channel on an OC-1 ring terminating on a pair of 26G2-U OLIUs and a DS1 port in the low-speed group associated with the 26G2-U OLIUs. The MXRVO functionality on the 26G2-U OLIUs is used. Note that it is NOT possible to connect between a channel on an OC-1 ring terminating on a pair of 26G2-U OLIUs and a 26G2-U/DS1 combination in a different function unit.

§ MXRVO functionality within the 26G2-U OLIU is NOT used. Rather, a separate pair of MXRVOs in a different FN group are used.

¶ Cross-connections from one OC-1 ring to a different OC-1 ring in a different function unit.

** One of the pair of function unit slots will be empty.

†† Cross-connections from one OC-1 ring to a different OC-1 ring in the same function unit.

‡‡ The mixing of 0x1, Pass-Through, and local Add/Drop cross-connects is supported beginning with R13.0.

§§ The mixing of 0x1, Pass-Through, and local Add/Drop cross-connects is supported beginning with R11.0.

Table 6-10. DDM-2000 OC-12 Linear Cross-Connects Allowable (Main to Function Unit)

From MAIN		To FUNCTION UNIT		
Circuit Pack	**Cross-Connect Type**	**21-type***	**3DS3**	**3STS1E**
23-type	Two-Way STS	1.1	1.0	2.1
	Two-Way 3C	2.0		

* The TSI slots must be equipped with the BCP3 TSI circuit packs.

Table 6-11. DDM-2000 OC-12 Ring Cross-Connects Allowable (Main to Main)

From MAIN		To MAIN
Circuit Pack	**Cross-Connect Type**	**23-type**
23-type	Pass-Through STS	3.0
	Drop/Continue STS	3.0
	Drop/Continue 3C	5.0
	Unprotected Video Broadcast 3C	5.0

Table 6-12. DDM-2000 OC-12 Ring Cross-Connects Allowable (Main to Function Unit)

From MAIN		To FUNCTION UNIT		
Circuit Pack	**Cross-Connect Type**	**21-type***	**3DS3**	**3STS1E**
23-type	Add/Drop STS	5.0	3.0	3.0
	Add/Drop 3C	5.0		
	Dual 0x1 STS	3.1		
	Single 0x1 STS	5.0		
	Dual 0x1 STS-3c	5.2		
	Single 0x1 STS-3c	5.2		
	Drop/Continue STS	5.0	3.1 †	3.0
	Drop/Continue 3C	5.0		
	Unprotected Video Broadcast 3C	5.0		

* A 21-type OLIU in a function unit is in “1+1” (unprotected or 1+1 line protected) configuration, not a “0x1” (ring) configuration.

† End-to-end SONET maintenance signaling is not provided for dual-ring interworking applications.

Physical Arrangements

Shelf Configurations

A single DDM-2000 OC-3 shelf supports various shelf configurations including:

- Terminating
- Hubbing
- STS-1 drop
- EC-1 electrical multiplexer
- DS1 add/drop
- Ring
- Dual ring interworking (DRI)
- Optical extension
- VT/STS Hairpin
- DDM-2000 FiberReach host
- Dual homing.

A single DDM-2000 OC-12 shelf supports various shelf configurations including:

- Terminating (DS3/EC-1 low-speed interfaces)
- Terminating (DS1/EC-1 low-speed interfaces)
- Hubbing
- OC-12 add/drop
- OC-12 STS-1 path switched ring
- OC-12 STS-1/VT1.5 path switched ring (0x1)
- Dual homing
- STS-3c broadcast
- OC-3c transport
- OC-12 Regenerator.

OC-3 Terminating Shelf

Figure 6-22 shows an example of the OC-3 terminating shelf, used for point-to-point network applications and as the CO terminal of multispan loop access applications. The OC-3 terminating shelf uses the two main OLIU slots to interface an OC-3 line to three function unit positions (A, B, C). Function unit and OLIU circuit packs are equipped in protection pairs, one service and one protection (denoted 1 and 2[P])]. Low-speed interface growth proceeds in STS-1 increments at the function unit slots. A DS3 interface is provided by the DS3 circuit pack (shown in slot C), an EC-1 interface is provided by the STS1E circuit pack in slot B, while DS1 services use the MXRVO function unit circuit pack. DS1 service growth proceeds in increments of four DS1s by equipping low-speed slots with DS1 or DS1PM circuit packs up to a maximum of seven service units and one protection unit per Multiplexer. Thus, each protected 28 DS1 "muldem" requires two MXRVO and eight DS1/DS1PM circuit packs. If DS1PM service circuit packs are equipped, the protection slot must also be equipped with a DS1PM circuit pack. Also, two MXRVO circuit packs (service and protection) must always be equipped whenever DS1PM circuit packs are equipped in the associated low-speed group.

Duplicated TGS or TG3 circuit packs distribute local clock signals to the OLIU and function unit circuit packs.

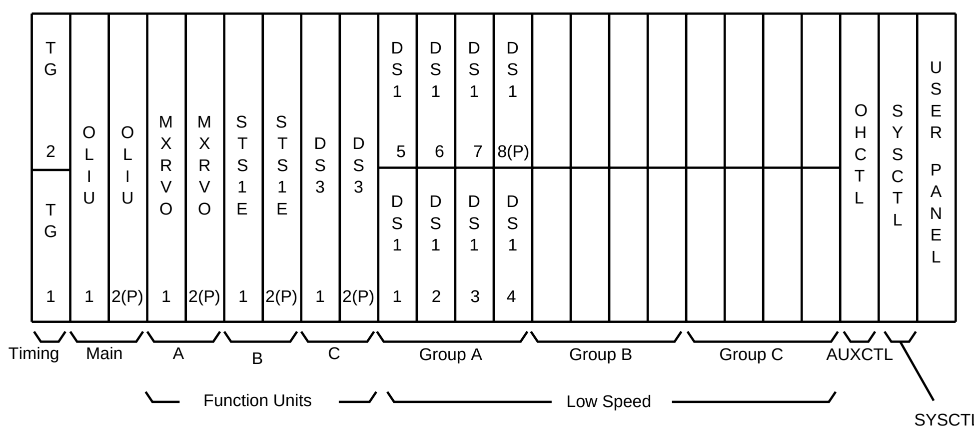


Figure 6-22. DDM-2000 OC-3 Terminating Shelf

OC-3 Hub Shelf

The OC-3 hub shelf (Figure 6-23) supports multiplexing and transport between a source node, a hub node, and two remote nodes. This example drops STS-1 #1 from the main OC-3 interface to 28 DS1 interfaces in the A-group, routes STS-1 #2 out of the OC-3 interface in the B-group, and routes STS-1 #3 out of the OC-3 in the C-group.

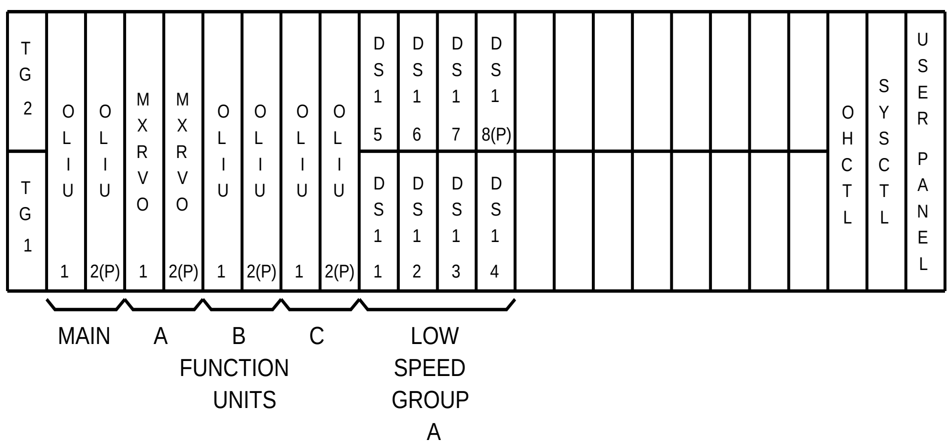


Figure 6-23. DDM-2000 OC-3 Hub Shelf

OC-3 STS-1 Drop Shelf

The STS-1 drop shelf is shown in Figure 6-24. The OLIU circuit packs are equipped in the C group as well as main positions. This example drops STS-1 #1 from the main OC-3 interface to 28 DS1 interfaces in the A group and routes STS-1 #2 and #3 out of the OC-3 interface in the C group. A DS3 service could also be dropped from STS-1 #1 to a DS3 circuit pack in the A function unit slot. Alternatively, STS-1 #2 could terminate at the shelf by equipping the B group with DS1 or DS3 interfaces. If the shelf is equipped with only OLIU circuit packs in the Main and C function unit slots, the shelf can function as an OC-3 or OC-3c repeater.

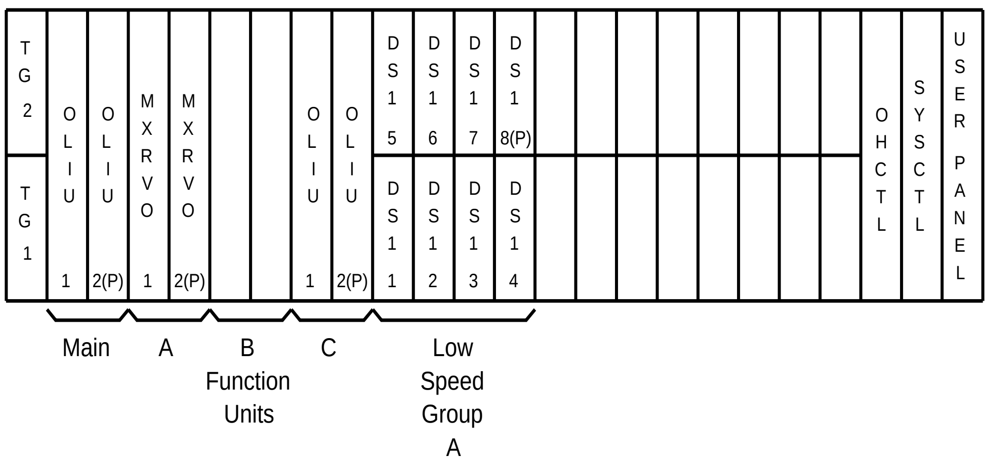


Figure 6-24. DDM-2000 OC-3 STS-1 Drop Shelf

EC-1 Electrical Multiplexer Shelf

Figure 6-25 shows the EC-1 electrical multiplexer shelf. Equipping the DDM-2000 OC-3 with DS1 and STS1E circuit packs provisioned in high-speed mode and DS1 circuit packs allows multiplexing of DS1 signals directly to an EC-1 high-speed electrical signal for intraoffice transport. This configuration supports up to three EC-1 interfaces. This configuration is only supported in linear Releases 8.0 and 8.1.

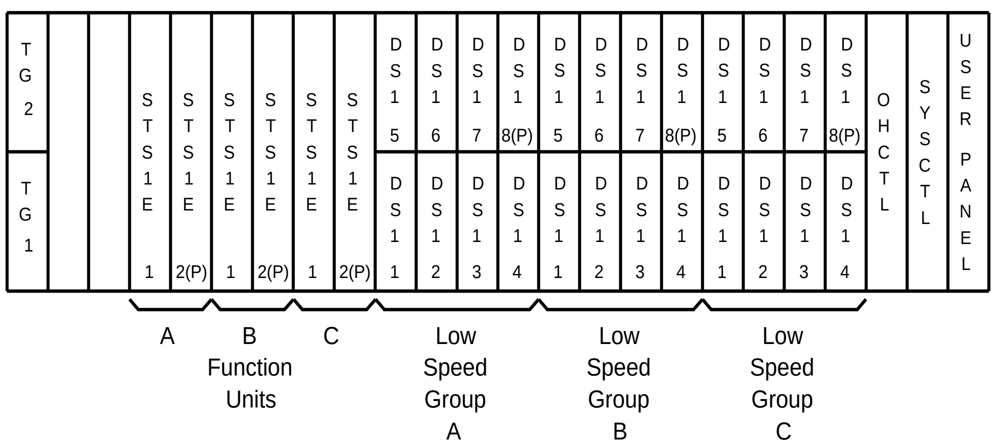


Figure 6-25. DDM-2000 OC-3 EC-1 Electrical Multiplexer Shelf

OC-3 DS1 Add/Drop Shelf

An example of a DS1 add/drop shelf in an intermediate node of an add/drop network is shown in Figure 6-26. The 22-type OLIU circuit packs are equipped in the C Function Unit Group as well as the Main positions. This configuration supports up to 56 DS1 interfaces in an add/drop configuration. Function Units A and B can also optionally support DS3 interfaces, EC-1 interfaces, or 22-type circuit packs for optical extensions.

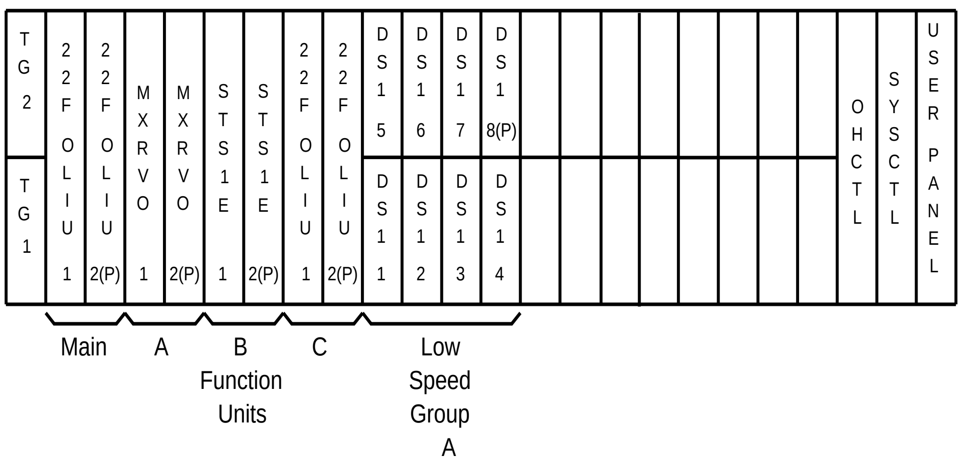


Figure 6-26. DDM-2000 OC-3 DS1 Add/Drop Shelf

OC-3 Ring Shelf

An example of an OC-3 ring shelf is shown in Figure 6-27. The 22-type OLIU circuit packs are equipped in the Main positions. The ring shelf optionally supports DS1, DS3, and EC-1 low-speed interfaces. Total ring capacity must not exceed 84 DS1s.

The shelf can be used in an OC-12 VT1.5 path switched ring (0x1) application. In Release 7.1, the DCC must be provisioned to support this application.

Beginning with Release 11or 15, equipping the main slots with 24-type or 29-type OLIUs allows the shelf to provide an OC-12 ring interface.

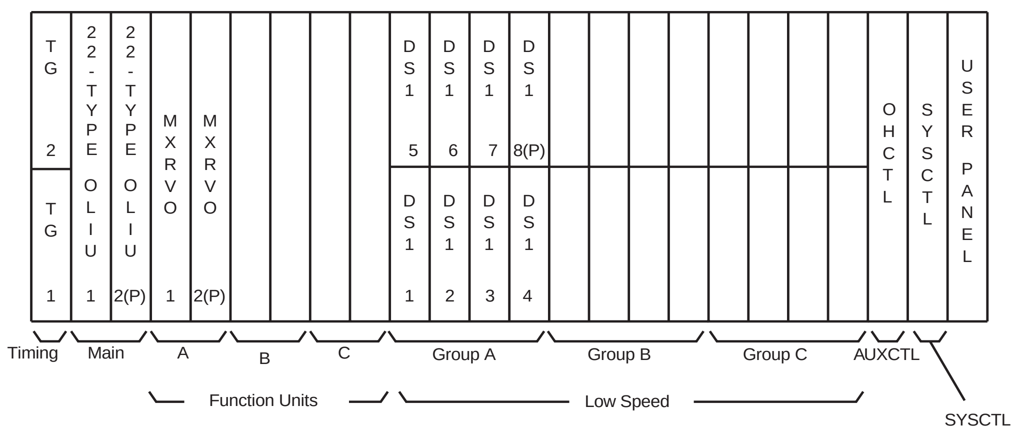


Figure 6-27. DDM-2000 OC-3 Ring Shelf

OC-3 Dual Ring Interworking (DRI) Shelf

An example of an OC-3 DRI shelf is shown in Figure 6-28. The 22-type OLIU circuit packs are equipped in the Main positions and can be equipped in Function Units A, B, or C. At least one pair of STS1E circuit packs must be equipped in at least one of the Function Unit slots. A DRI shelf can also support MXRVOs and DS3 interfaces for non-DRI circuits.

Starting with Release 7.2, DRI traffic can be interconnected using 22-type OLIU circuit packs in the Function Unit slots.

Beginning with Release 11 or 15, equipping the main slots with 24-type or 29-type OLIUs allows the shelf to provide an OC-12 ring interface.

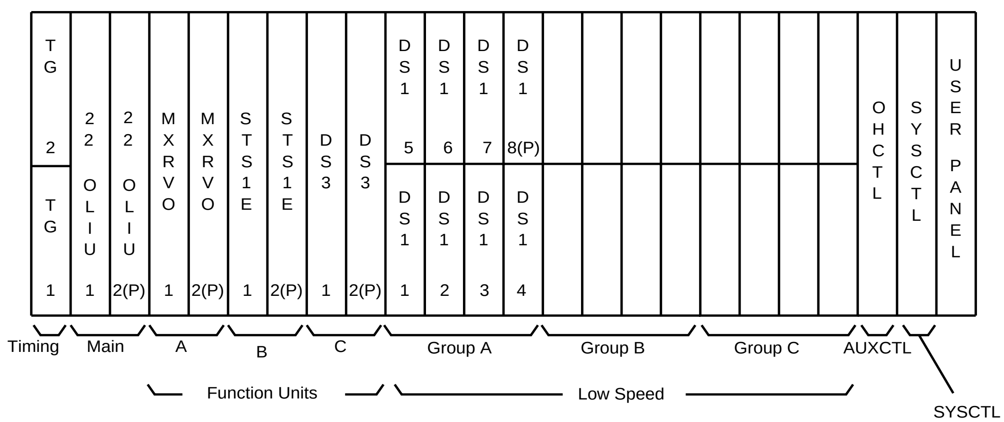


Figure 6-28. DDM-2000 OC-3 DRI Shelf

OC-3 Ring Shelf with Optical Extension

An example of an OC-3 ring shelf with an optical extension is shown in Figure 6-29. The 22-type OLIU circuit packs in the Main positions carry ring traffic. The 22-type OLIU circuit packs in Function Unit B or C positions provide the optical extension capability. Starting with Release 9.0, optical extensions can also be provided from Function Unit A because of the additional DCC capability provided by the new controllers.

Beginning with Release 11 or 15, equipping the main slots with 24-type or 29-type OLIUs allows the shelf to provide an OC-12 ring interface.

Beginning with Release 15.0, a 1+1 optical linear TARP extension is provided from the Main ring interface (Function Units of the host NE) without the need to use linear software.

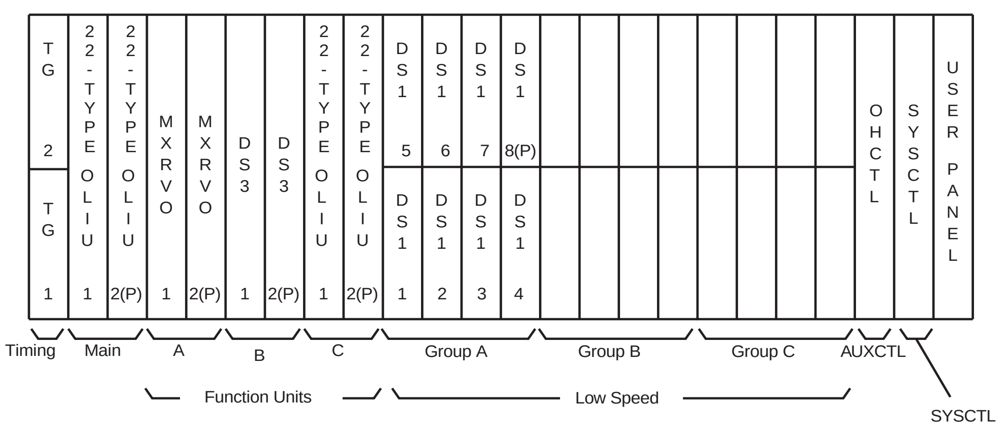


Figure 6-29. DDM-2000 OC-3 Ring Shelf With an Optical Extension

OC-3 VT/STS Hairpin Shelf

An example of an OC-3 shelf equipped to allow both VT and STS hairpin cross-connects is shown in Figure 6-30. The VT/STS hairpin feature allows cross-connections from Function Units C to A, or C to B. In this example, the VT hairpin feature allows cross-connections between Function Units A and C when those Function Units are equipped with 22-type OLIUs, STS1E, or MXRVO circuit packs (MXRVO-to-MXRVO cross-connections are not allowed); the STS hairpin feature allows cross-connections between Function Units B and C when equipped with 22-type OLIUs, STS1E, or DS3 circuit packs.

The hairpin feature keeps local VT/STS traffic from being placed on the OC-3 ring. This increases the usable bandwidth on the OC-3 ring and may remove the need to add additional OC-3 shelves.

Beginning with Release 11 or 15, equipping the main slots with 24-type or 29-type OLIUs allows the shelf to provide an OC-12 ring interface.

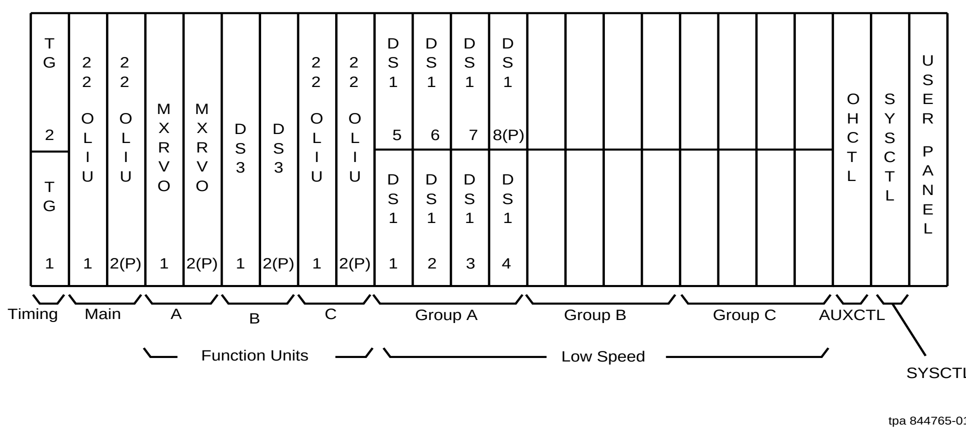


Figure 6-30. DDM-2000 OC-3 VT/STS Hairpin Shelf

OC-3 Dual Homing Shelf

Figure 6-31 shows a DDM-2000 OC-3 shelf equipped for a dual homing configuration, allowing two hosts to be active on the same OC-3 ring. This allows a 0x1 application where traffic is routed to both hosts to provide host protection. Each host node is connected to the low-speed ring through OLIUs in the Function Unit. In this application, two DDM-2000 OC-3 shelves are hosting one or two DDM-2000 FiberReach OC-1 rings.

Beginning with Release 11 or 15, equipping the main slots with 24-type or 29-type OLIUs allows the shelf to provide an OC-12 ring interface.

Beginning with Release 15, two DDM-2000 OC-3/OC-12 shelves can host one or two DDM-2000 FiberReach/OC-3 rings for STS-1/VT1.5 or STS-3c 0X1 application.

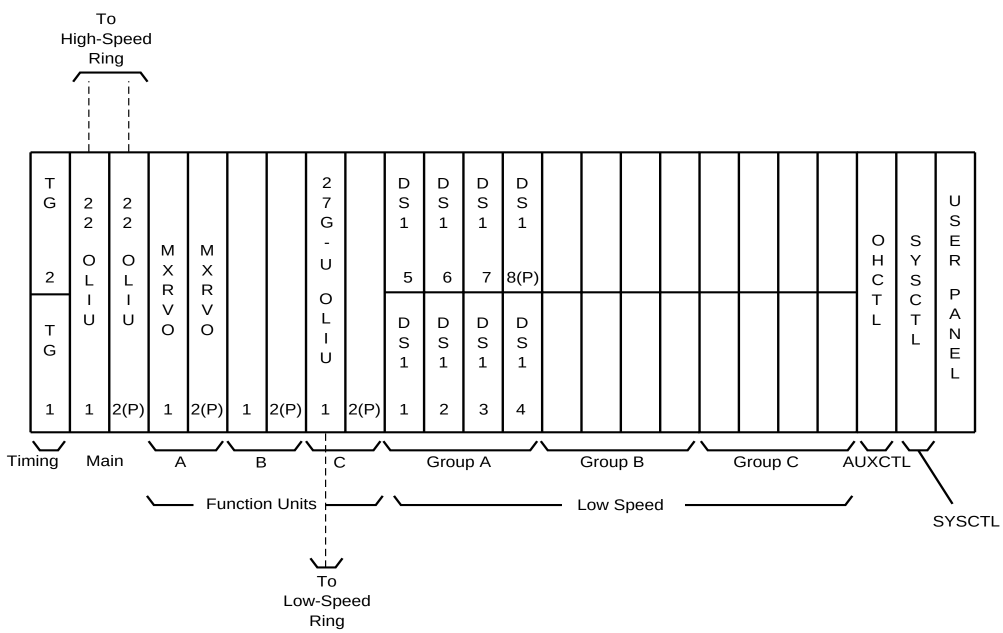


Figure 6-31. DDM-2000 OC-3 Dual Homing Shelf

OC-3 DDM-2000 FiberReach Host Shelf

An example of an OC-3 DDM-2000 FiberReach host shelf is shown in Figure 6-32. As a host node, the OC-3 shelf provides add/drop capability between the OC-3 ring and OC-1 rings (DDM-2000 FiberReach extensions). The ring (0x1) cross-connection between the rings supports full TSI assignment between the low-speed and high-speed time slots while preserving independent service and protection paths between the rings. Using 27-type dual OC-1 OLIUs in the Function Units, a single OC-3 shelf can support up to six OC-1 extensions in a single-homing arrangement (the 27-type OLIUs must be equipped in pairs). When fully loaded with six 27-type OLIUs, the OC-3 shelf can support up to 12 OC-1 extensions in a dual-homing arrangement (for a maximum capacity of 84 DS1s).

Beginning with Release 11 or 15, equipping the main slots with 24-type or 29-type OLIUs allows the shelf to provide an OC-12 ring interface.

Note that In Group 1 or 3 shelves, a BBF5 jumper circuit pack must be installed in Slot 8 of the low-speed group associated with the Function Unit equipped with a pair of 27-type OLIUs. In addition, a BBF5 must be installed in Slot 4 if both OLIUs in the function unit are 27G2-Us.

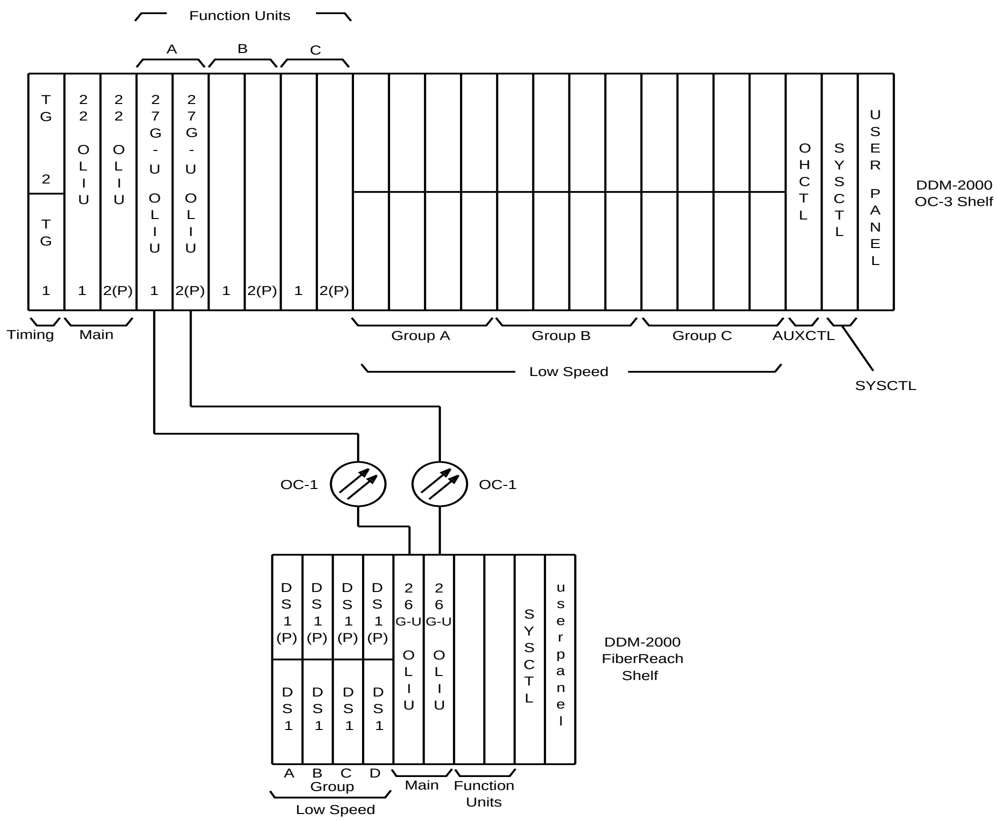


Figure 6-32. OC-3 DDM-2000 FiberReach Host Shelf

OC-3 FiberReach Host Shelf - Enhanced Routing

When hosting FiberReach Enhanced Routing Topologies (OC-1 Ring Pass-Through, OC-1 Ring Hairpin Single-Homed and Dual-Homed, and OC-1 Ring Hairpin Local Drop), an OC-3 shelf changes in only two ways. First, 27G2-U OLIUs must be used instead of 27G-U OLIUs. Second, when using Group 1 or Group 3 shelves, two BBF5 jumper circuit packs must be installed in the low-speed group associated with the Function Unit equipped with the 27G2-U OLIUs, one in slot 4 and one in slot 8. As an example, Figure 6-33 shows a host shelf that is equipped for the OC-1 Ring Hairpin Local Drop application.

Beginning with Release 11 or 15, equipping the main slots with 24-type or 29-type OLIUs allows the shelf to provide an OC-12 ring interface.

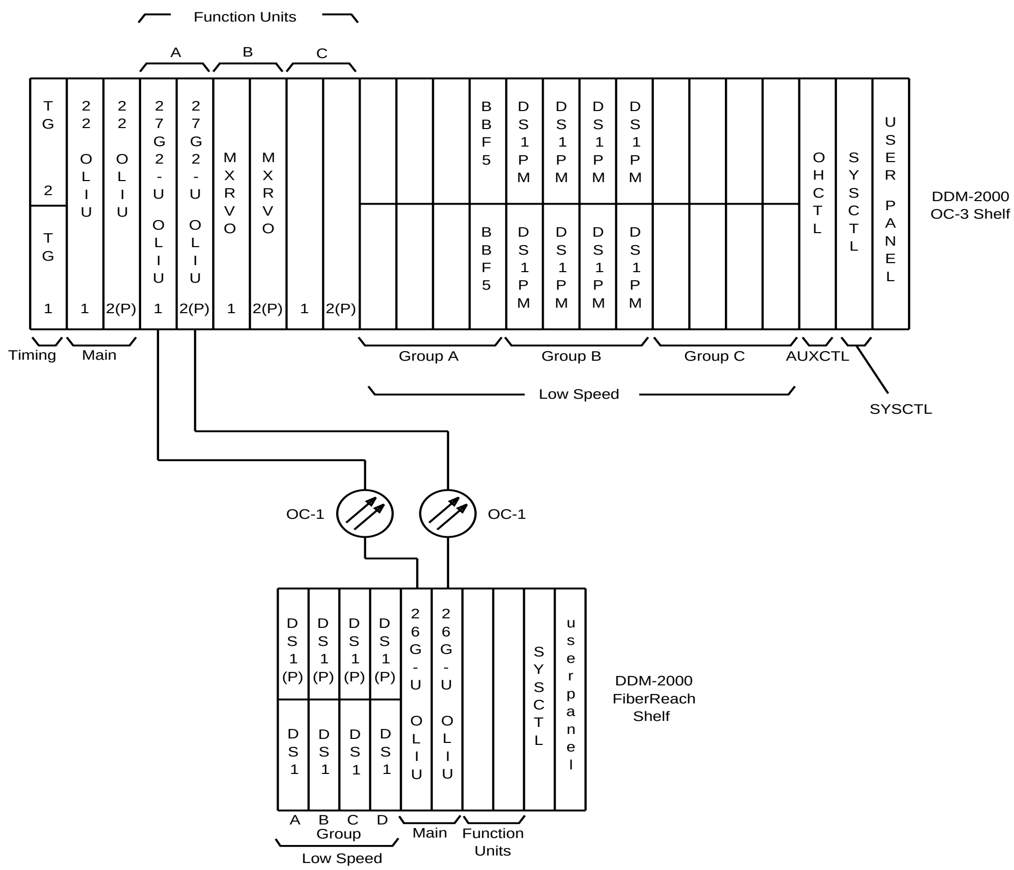


Figure 6-33. OC-3 DDM-2000 FiberReach Host Shelf - Enhanced Routing Topologies

OC-3 FiberReach Host Shelf - Enhanced Routing with 26G2-U OLIU

Figure 6-34 shows enhanced routing with the single OC-1 26G2-U OLIU in place of the dual OC-1 27G2-U OLIU. The 26G2-U can drop DS1s without the need for the MXRVO Multiplexer or BBF5 Jumper circuit packs. The 26G2-U provides OC-1 Ring Pass-Through, OC-1 Ring Hairpin Single-Homed and Dual-Homed, and OC-1 Ring Hairpin Local Drop applications. The Group 4 shelf is required.

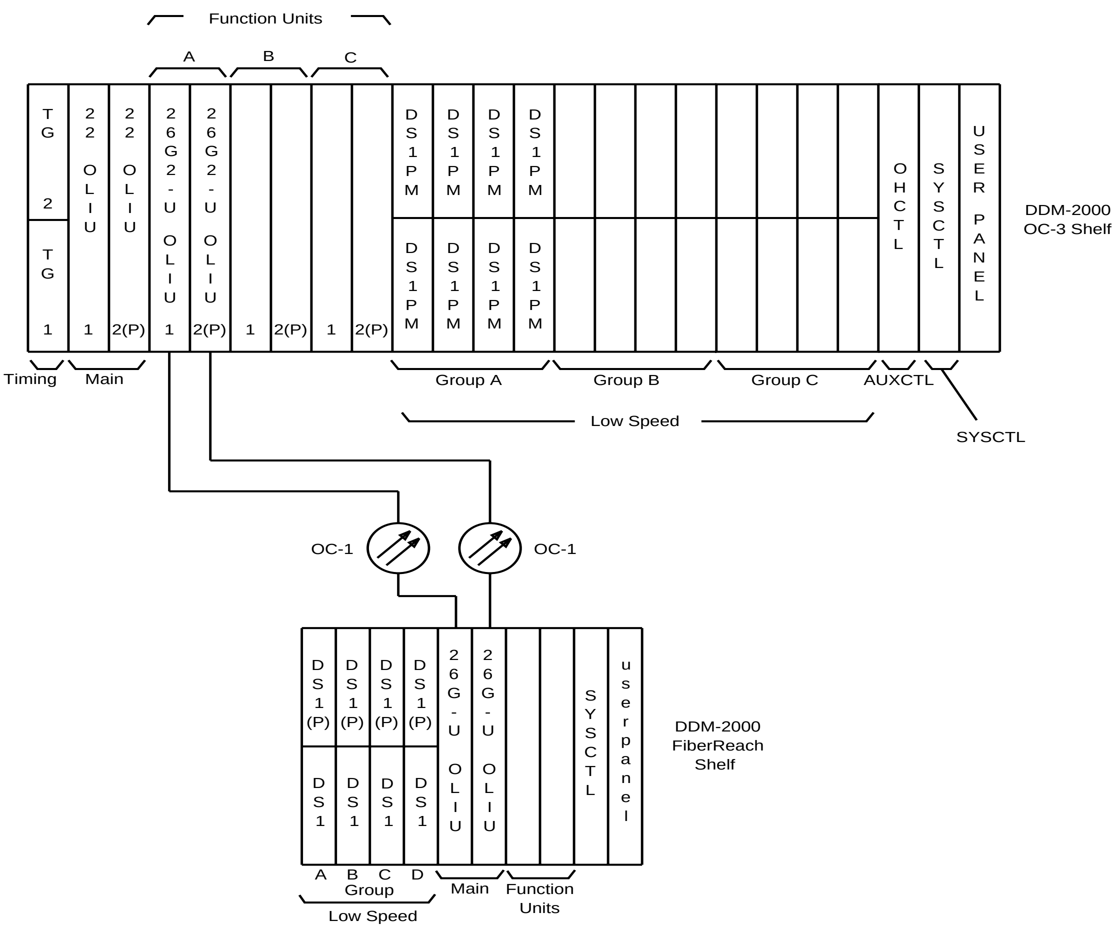


Figure 6-34. OC-3 DDM-2000 FiberReach Host Shelf - Enhanced Routing with 26G2-U OLIU

LAN Interface

Figure 6-35 shows examples of BBG2B MXRVO circuit packs in function unit B, coupled with BBF9 or BBF10 LAN circuit packs in slots 1 through 6 of low-speed group B.* Two BBG2B or BBG2 MXRVOs are required when LAN circuit packs are installed in low speed slots. A LAN circuit pack uses two low speed slot positions and is therefore **not** protected.

In function unit B the BBG2B supports one to three LAN interfaces, the LANs are connected through the backplane to the BBG2Bs in function unit group B. The LAN circuit packs convert a 100BaseFX LAN optical signal or a 10/100BaseT electrical signal and pass it on to the BBG2Bs. These interfaces provide for either electrical or optical LANs. If the function unit group contains a BBG2 MXRVO only two BBF9 or BBF10 LAN circuit pack is allowed in a low-speed group. A maximum of three LAN circuit packs are allowed per LOW SPEED GROUP, but no more than six per shelf due to cabling limitations. Both FUNCTION UNITS slots must be equipped with MXRVO circuit packs. Mixing with DS1, DS1PM, or T1EXT circuit packs is allowed within the same LOW SPEED GROUP.

Beginning with Release 15, equipping the main slots with 29-type OLIUs allows the shelf to provide an OC-12 ring interface and support a LAN interface.

* The example in Figure 6-35 uses a Group 4 shelf. If a Group 3 shelf is used, the G3 to G4 Front Cover Upgrade Kit must be installed for proper cable dressing.

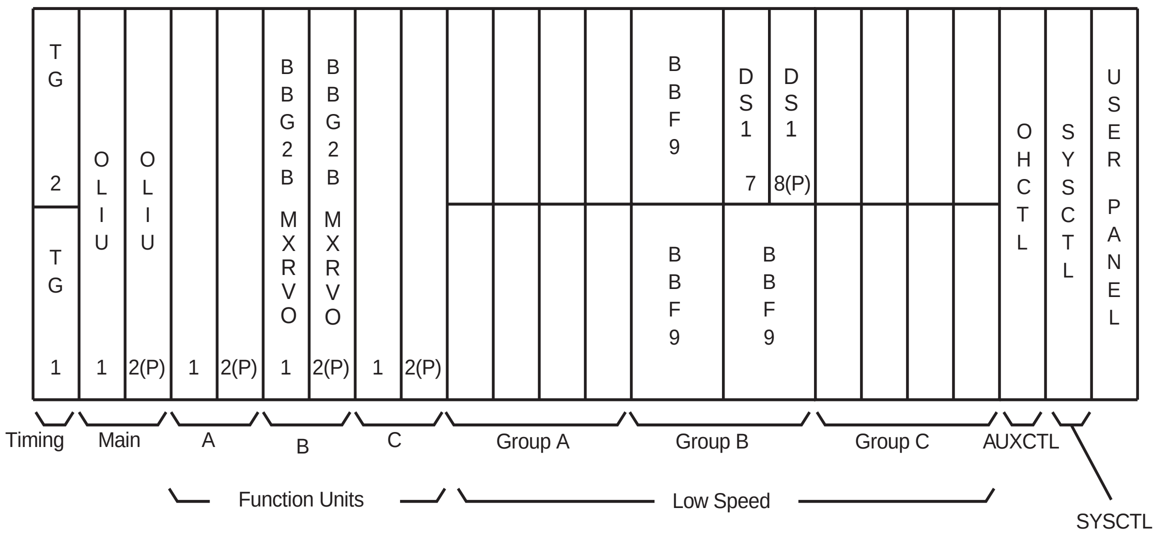


Figure 6-35. OC-3/OC-12 Shelf with LAN Interface

HDSL Interface

The BBF8 circuit pack provides for High bit rate Digital Subscriber Line (HDSL) interface capability on the DDM-2000 OC-3 shelf. Each BBF8 allows the transport of two T1 payloads, for up to 12,000 feet, over two metallic 24 AWG twisted-pair lines. Figure 6-36 shows examples of HDSL circuit packs providing this capability. Function group A is an example of a 1xN (1x2) protected configuration, while function group C is in the unprotected mode. At the present time there is a limit of three HDSL circuit packs per function unit.

Beginning with Release 11 or 15, equipping the main slots with 24-type or 29-type OLIUs allows the shelf to provide an OC-12 ring interface.

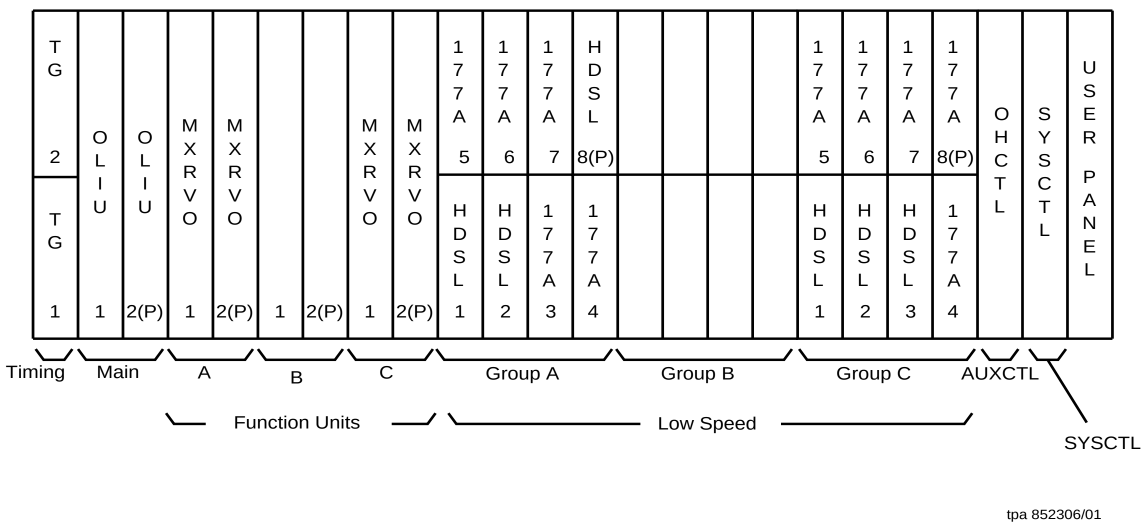


Figure 6-36. OC-3/OC-12 Shelf with HDSL Interface

T1EXT Interface

The BBF6 circuit pack provides for T1 Extension (T1EXT) interface capability on the DDM-2000 OC-3 shelf. Each BBF6 allows the transport of two T1 payloads, for up to 6,000 feet, over two metallic 22 AWG twisted-pair lines. Figure 6-37 shows examples of T1EXT circuit packs providing this capability. Function group A is an example of a 1xN (1x2) protected configuration, while function group C is in the unprotected mode. The corresponding function unit group must be equipped with two BBG2B MXRVO circuit packs.

Beginning with Release 15, equipping the main slots with 29-type OLIUs allows the shelf to provide an OC-12 ring interface and a T1 Extension (T1EXT) interface.

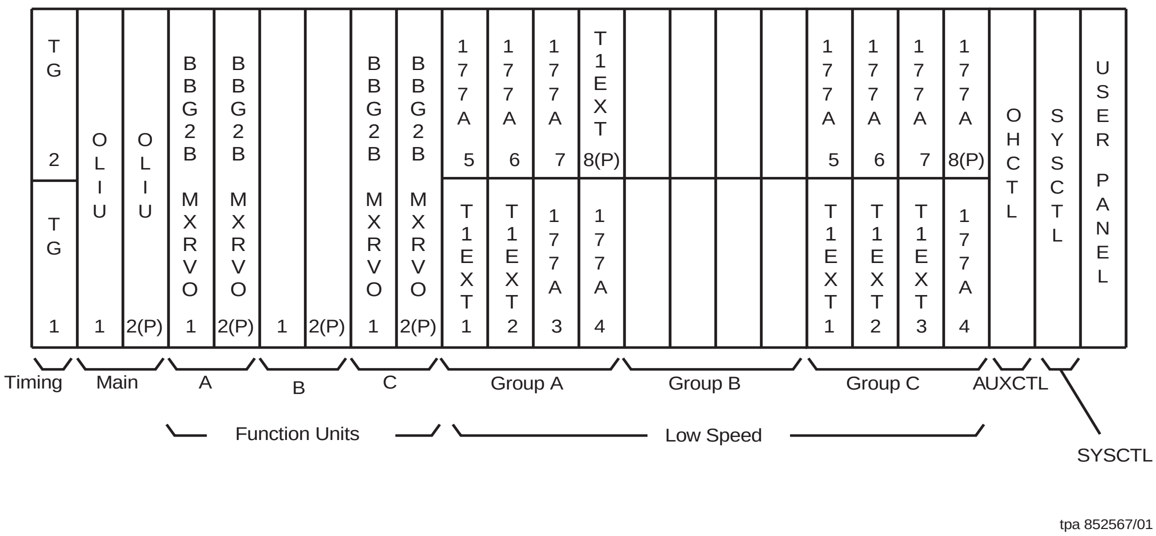


Figure 6-37. OC-3/OC-12 Shelf with T1EXT Interface

Transmultiplexer

The DS3 Transmux interface circuit pack (TMUX) provides a mapping between the DS3 low-speed signal and internal STS-1 signals. Up to three DS3 interfaces (1x1 protected) may be supported per shelf. Figure 6-38 shows TMUX packs in function unit A.

In the transmit direction, the BBG20 TMUX circuit pack accepts one 44.736 Mb/s bipolar 3-zero substitution (B3ZS) coded DS3 signal and demultiplexes it into 28 DS1s. Performance monitoring is performed on the DS1s before they are mapped into floating VT1.5s. The 28 VT1.5s are then multiplexed into STS-1 payload envelope(s) using SONET asynchronous mapping. The STS-1 path overhead and pointer bytes are added and the resulting signal is sent to the high-speed OLIU circuit pack.

In the receive direction the reverse process takes place: The STS-1 signal(s) from the OLIU circuit pack goes through STS-1 pointer interpretation, path overhead is removed and processed, and the twenty-eight VT1.5s are stripped of their overhead to produce 28 DS1s. The DS1s are then multiplexed back into the DS3.

Beginning with Release 11.1 or 15, equipping the main slots with 24-type or 29-type OLIUs allows the shelf to provide an OC-12 ring interface and a transmultiplexer interface.

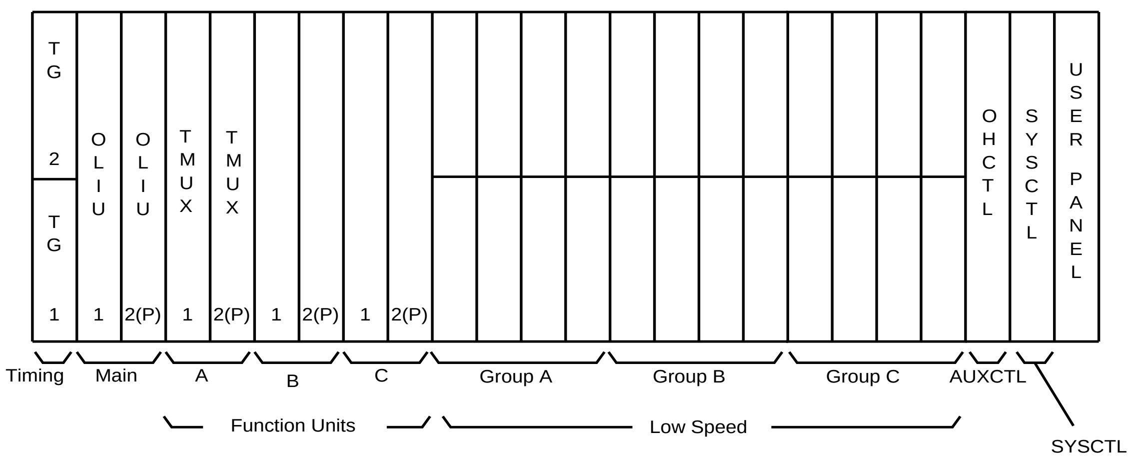


Figure 6-38. OC-3/OC-12 Shelf with Transmultiplexers

OC-12 Terminating Shelf (DS3/EC-1 Low-Speed Interfaces)

Figure 6-39 shows the OC-12 terminating shelf that supports point-to-point network applications. The terminating shelf uses the two main optical interface circuit packs (OC-12 OLIU) in the Main B shelf positions to interface an OC-12 line to the STS-1 TSI packs. Growth proceeds in three STS-1 increments by equipping the low-speed slots with the triple DS3 circuit packs or 3STS1E circuit packs. The maximum is 12 DS3 interfaces with 4 service and 4 protection units.

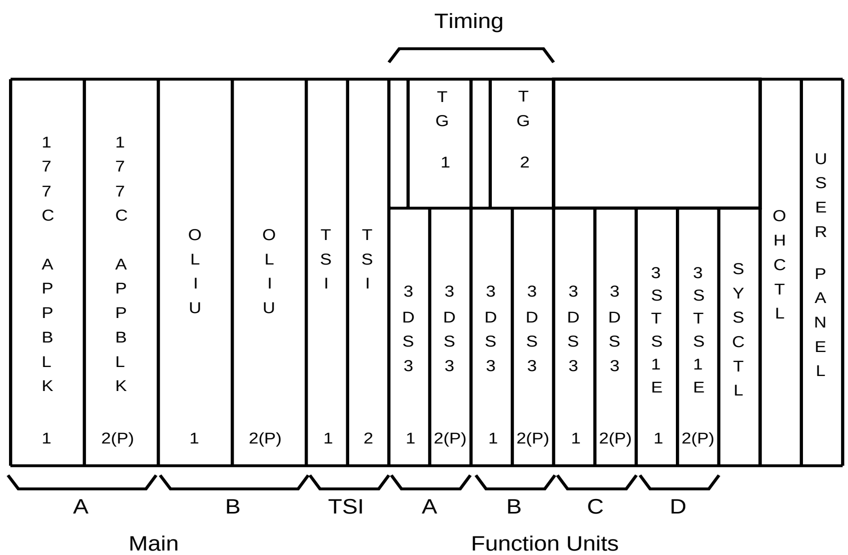


Figure 6-39. DDM-2000 OC-12 Terminating Shelf (DS3/EC-1 Low-Speed Interfaces)

OC-12 Terminating Configuration (DS1/EC-1 Low-Speed Interfaces)

Figure 6-40 shows the OC-12 terminating configuration using DS1/EC-1 low-speed interfaces. Interface to the low-speed shelf is made through the IS-3 (or OC-3) circuit packs, one service and one protection pack per interface. The IS-3 circuit packs replace the OLIU circuit packs in the Main slots on the DDM-2000 OC-3 shelf. This configuration supports a high-speed OC-12 interface with 84 DS1 terminations per DDM-2000 OC-3 shelf, up to a maximum of 336 DS1 terminations.

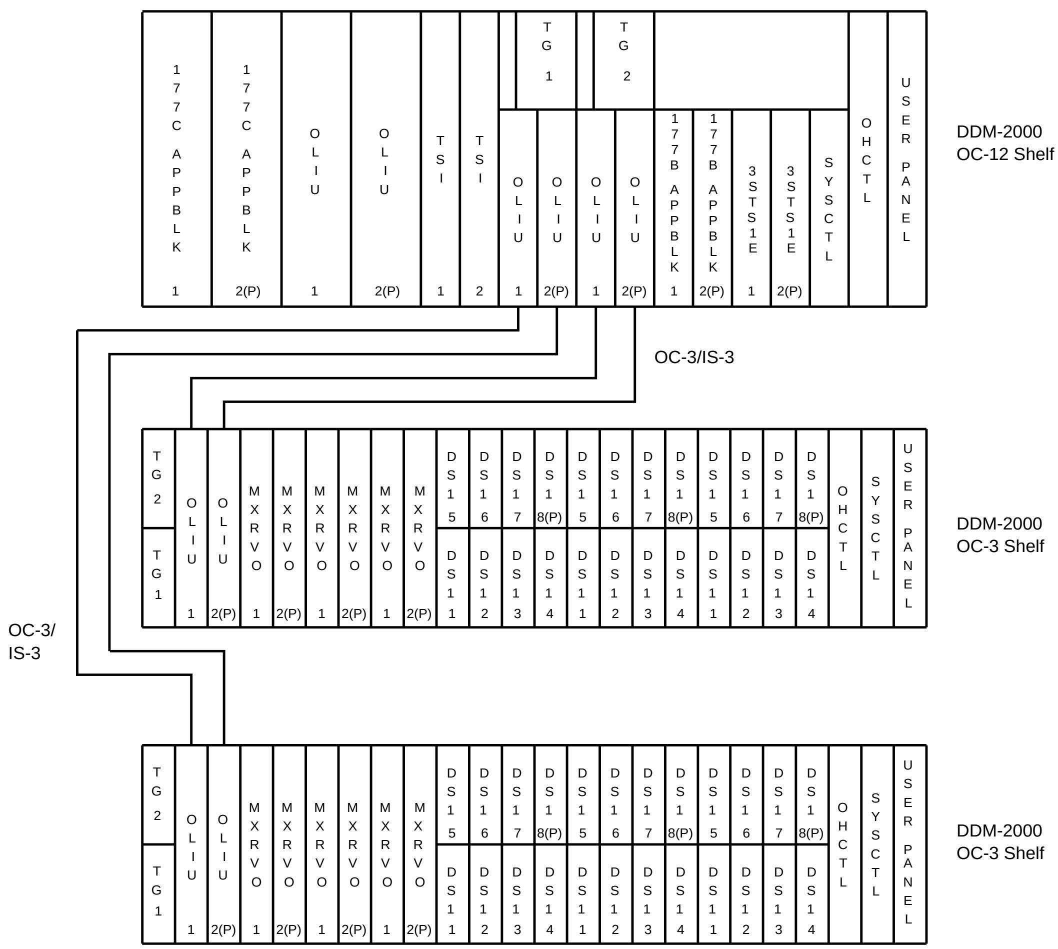


Figure 6-40. OC-12 Terminating Configuration (DS1/EC-1 Low-Speed Interfaces)

OC-12 Hub Shelf

Figure 6-41 shows the OC-12 hub shelf. The eight low-speed interfaces are equipped with four service and four protection OC-3 circuit packs. This configuration supports four OC-3 optical extensions; however, local drop configurations can be established by replacing OC-3 circuit packs with triple DS3, triple STS1E, or IS-3 circuit packs. This configuration can also support up to four OC-3 optical extensions through proper provisioning.

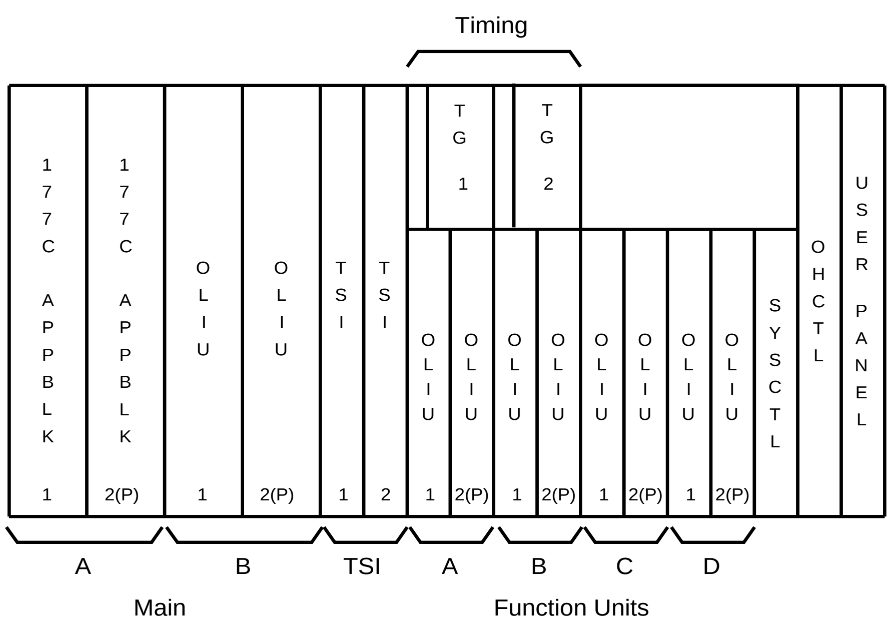


Figure 6-41. OC-12 Hub Shelf

OC-12 STS-1 Path Switched Ring Shelf

Figure 6-42 shows the DDM-2000 OC-12 Multiplexer shelf equipped for an STS-1 path switched ring application. One pair of OC-12 OLIU circuit packs are located in the Main B slots. The TSI slots must be equipped with TSI FLEX circuit packs. The Function Units can be equipped with triple STS1E, triple DS3, or OC-3 circuit packs. Figure 6-42 shows a configuration that supports up to three STS-1 and three DS3 interfaces and two OC-3 optical extensions. The optical extension OLIUs can provide transport for either three independent STS-1s or one STS-3c. DRI capabilities are available on STS-1 paths dropped by the 3STS1E interfaces.

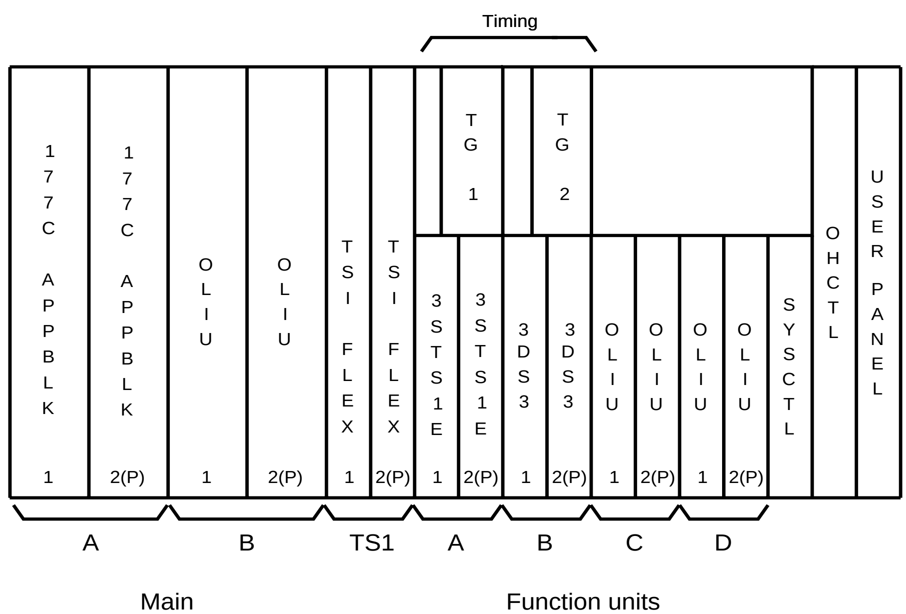


Figure 6-42. OC-12 STS-1 Path Switched Ring Shelf

OC-12 STS-1/VT1.5 Path Switched Ring Configuration

Figure 6-43 shows an example of a DDM-2000 OC-12 Multiplexer STS-1/VT1.5 path switched ring configuration. As in the DDM-2000 OC-12 Multiplexer STS-1 ring shelf, there is one set of OC-12 interfaces and a pair of TSI FLEX circuit packs. In this configuration, however, there is also an IS-3 interface to a DDM-2000 OC-3 Multiplexer shelf where VT1.5 level path protection switching is completed. This interface between DDM-2000 OC-3 and OC-12 Multiplexers is referred to as a "0x1" interface. In this case, the DDM-2000 OC-12 Multiplexer feeds the STS-1 paths directly from the two rotations of the OC-12 ring to the OC-3 shelf. Protection switching is done on the OC-3 Multiplexer shelf. The remaining Function Units can be equipped with 3DS3, 3STS1E, or OLIU circuit packs as desired. OLIUs can be used for optical extensions as in the OC-12 Multiplexer STS-1 level path switched ring for interconnection to additional DDM-2000 OC-3 Multiplexer shelves performing VT1.5 level path switching.

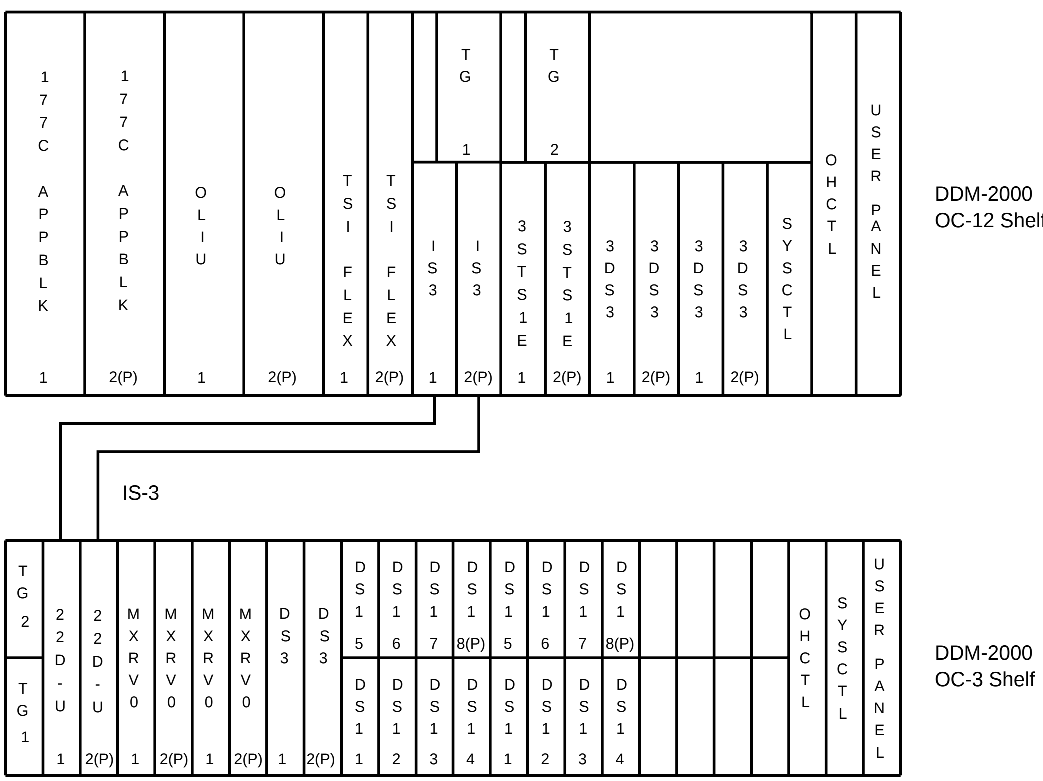


Figure 6-43. OC-12 STS-1/VT1.5 Path Switched Ring Configuration

OC-12 Dual Homing Shelf

Figure 6-44 shows a DDM-2000 OC-12 shelf equipped for a dual homing configuration, allowing two hosts to be active on the same OC-12 ring. This allows a 0x1 application where traffic is routed to both hosts to provide host protection. In this application, two DDM-2000 OC-12 shelves are hosting one OC-3 ring.

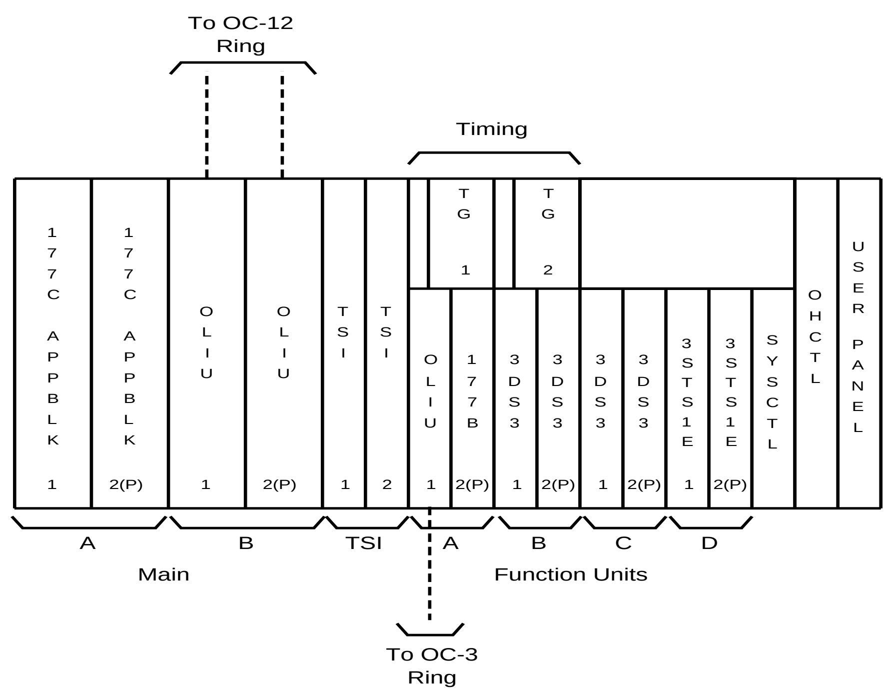


Figure 6-44. DDM-2000 OC-12 Dual Homing Shelf

OC-12 STS-3c Broadcast Shelf

Figure 6-45 shows a DDM-2000 OC-12 shelf equipped for an STS-3c broadcast application. This configuration uses a pair of OC-3s, provisioned as one-way STS-3cs, as input to a DDM-2000 OC-12 Multiplexer shelf. Each pair of OC-3s is then split and fed onto different rotations of the ring. **Each** drop (RT) location can then be provisioned to drop any or all of the STS-3cs to OC-3 or IS-3 circuit packs. Bandwidth on the ring, not provisioned for this application, can be used for other path switched ring applications as shown in the figure with 6 DS3s and 3 EC-1s.

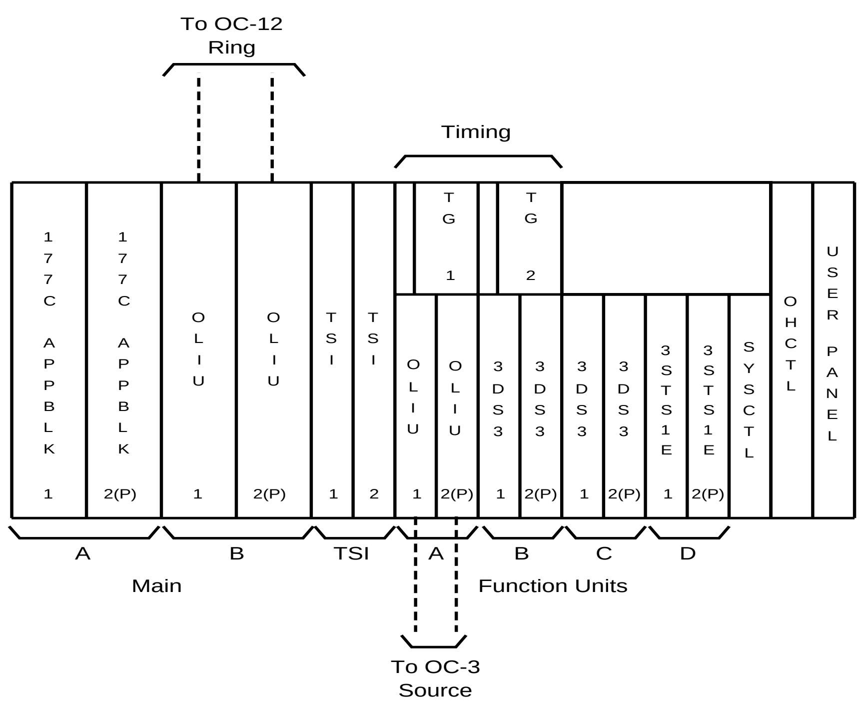


Figure 6-45. DDM-2000 OC-12 STS-3c Broadcast Shelf

OC-12 OC-3c Transport Shelf

Figure 6-46 shows a DDM-2000 OC-12 shelf equipped for an OC-3c transport application. The main application of a shelf, configured in this way, is transport of video or asynchronous transfer mode (ATM) signals. Bandwidth is mapped into STS-3c "bundles," and the bundles follow the same path to preserve the isochronous (known, periodic time interval) nature of the transported information.

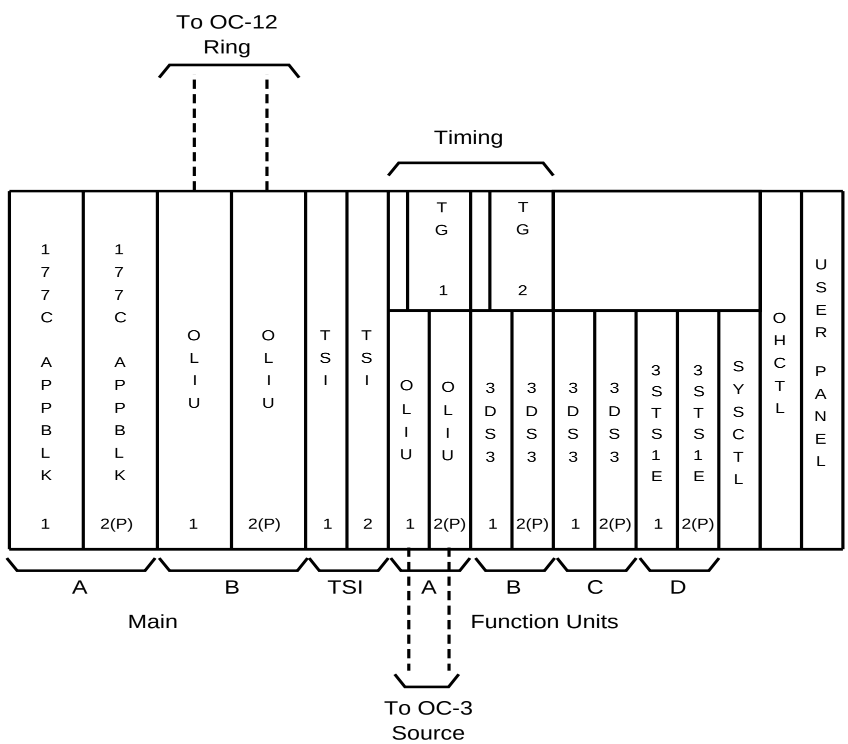


Figure 6-46. DDM-2000 OC-12 OC-3c Transport Shelf

OC-12 Regenerator Shelf

Figure 6-47 shows the OC-12 Regenerator shelf. The OC-12 Regenerator uses the same shelf unit as the OC-12 Multiplexer. The Main A and B shelf positions are equipped with four OC-12 regenerator circuit packs (23R-U REGENR). This configuration supports two bidirectional OC-12 lines. The 23R-U REGENR circuit pack was discontinued availability (DA) on 8/13/99.

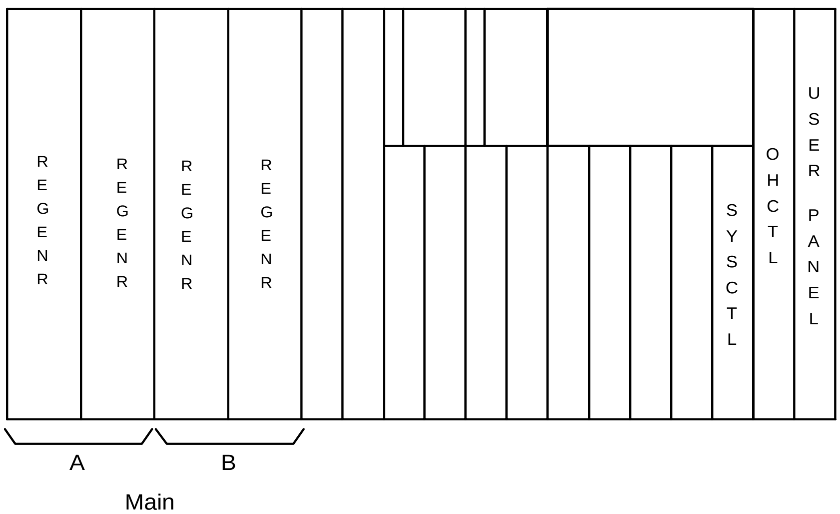


Figure 6-47. DDM-2000 OC-12 Regenerator Shelf

Network Bay Frames

The DDM-2000 OC-3 and OC-12 Multiplexers can be mounted in the ED-8C812-50, G11 and ED-8C812-50, G12 seismic bay frame kits. Figure 6-48 shows the rear (A) and front (B) access positioning of the DDM-2000 OC-3 and OC-12 Multiplexer in ED-8C812-50, G11 seismic bay frames. Also shown are the DDM-2000 OC-3 and OC-12 Multiplexers in an ED-8C812-50, G12 seismic bay frame with rear access only (C).

NOTE:
The mounting brackets on the DDM-2000 OC-3, OC-12, Heat Baffle, and Fan Shelf are designed to allow for mounting in standard 23-inch wide network bay frames and 23-inch wide EIA-type bay frames.

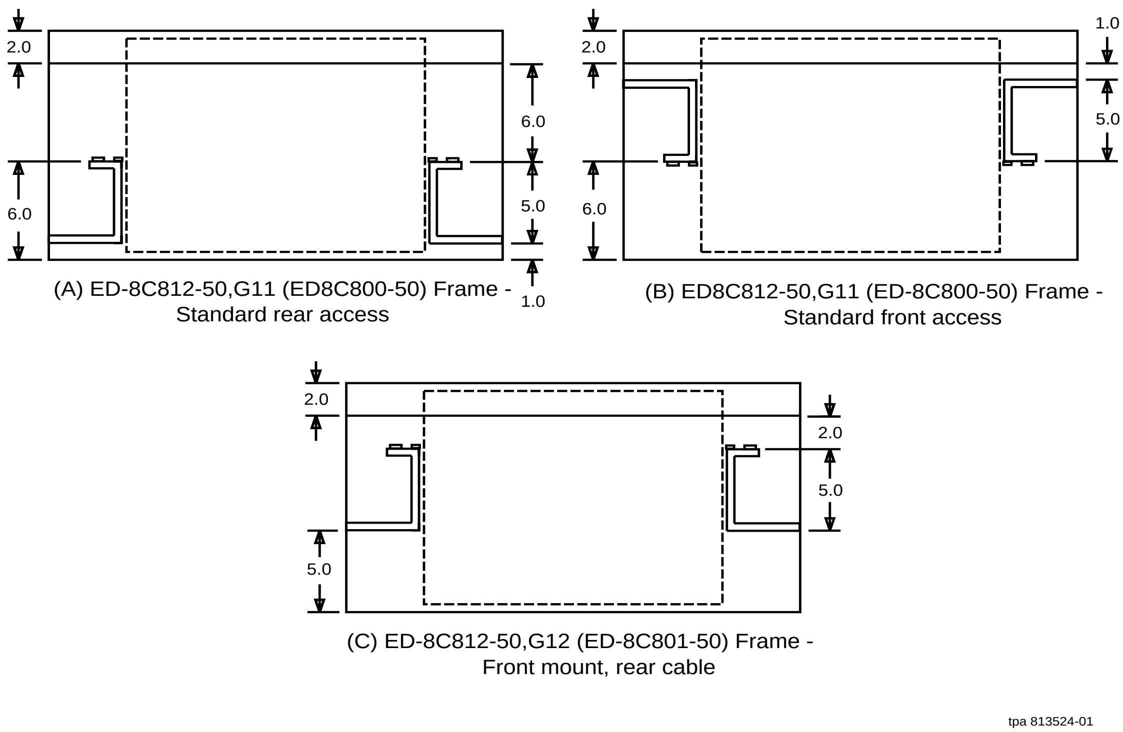


Figure 6-48. DDM-2000 OC-3 and OC-12 Multiplexer Shelf Mounting

A standard 7-foot fully-loaded bay arrangement (Figure 6-49) may be ordered. It contains six DDM-2000 OC-3 Multiplexers. This arrangement (ED8C906-30) can be configured with either front or rear access cabling (with or without a fuse panel) and supports the full set of the OC-3 upgrade capabilities. For applications where a future upgrade to OC-12 is expected, a 7-foot bay arrangement also supports four DDM-2000 OC-3 Multiplexers plus the DDM-2000 OC-12 Multiplexer (Figure 6-49b) or three DDM-2000 OC-12 shelves (Figure 6-49c).

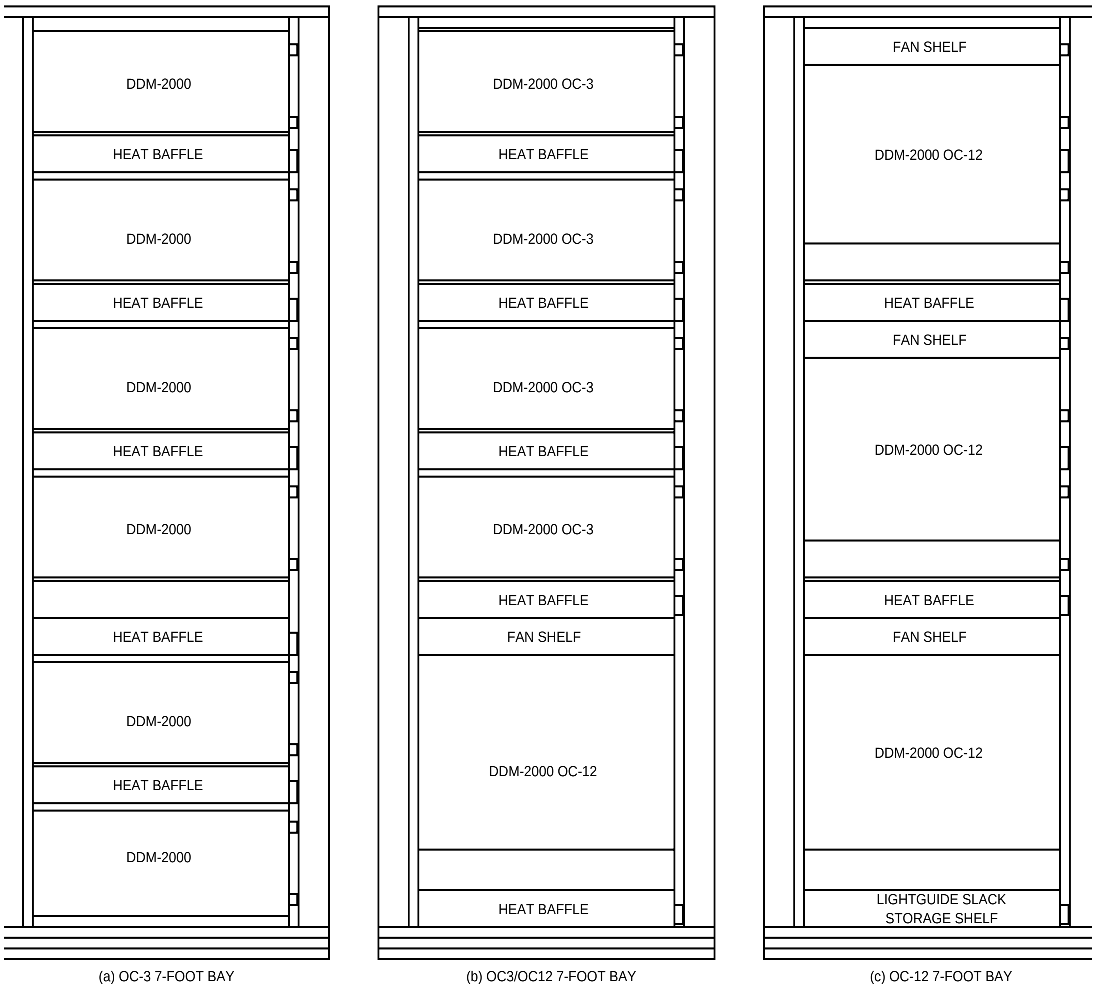


Figure 6-49. DDM-2000 OC-3 and OC12 Bay Arrangements

The OC-3 bay arrangement, with heat baffles between each shelf, supports all configurations of the OC-3 shelf.

DDM-2000 OC-3 Multiplexer shelf arrangements do not require fans in CO (controlled) environments.

The DDM-2000 OC-12 Multiplexer can be mounted stand-alone in an ED-8C500 bay with front and rear access cabling. A standard 7-foot bay arrangement contains three DDM-2000 OC-12 Multiplexers (Figure 6-49c).

Seismic Bay Frames

The ED-8C800-50, G1 and ED8C801-50, G1 seismic network bay frames, and ED8C812-50, G11 and ED8C812-50, G12 seismic network bay frame kits are designed for use in all earthquake zones, and in general, do not require top support at the 7-foot level. These frames meet Pacific Bell Equipment Framework Standard PBS-000-102PT. Shelf arrangements may be different for these bays. See ED-8C724-10 and ED-8C727-10 for OC-3 and OC-12 bay drawings respectively.

Cabinet Arrangements

The DDM-2000 OC-3 and OC-12 Multiplexers are available in a variety of standard cabinet arrangements for outside plant (51-type or 80-type) and customer location (90-type) installations. See 626-500-105, *80-Type Cabinets Ordering Information and Lettering Guide,* and 626-500-115, *90-Type Cabinets Coding and Ordering Information,* for more information.

Figure 6-50 shows the DDM-2000 OC-3 Multiplexer mounted in an 80D bulk power cabinet with five *SLC* series 5 carrier system dual channel banks (960 voice-frequency lines) and a DDM-Plus shelf (28 T1 or seven quad DS1 optical interfaces).

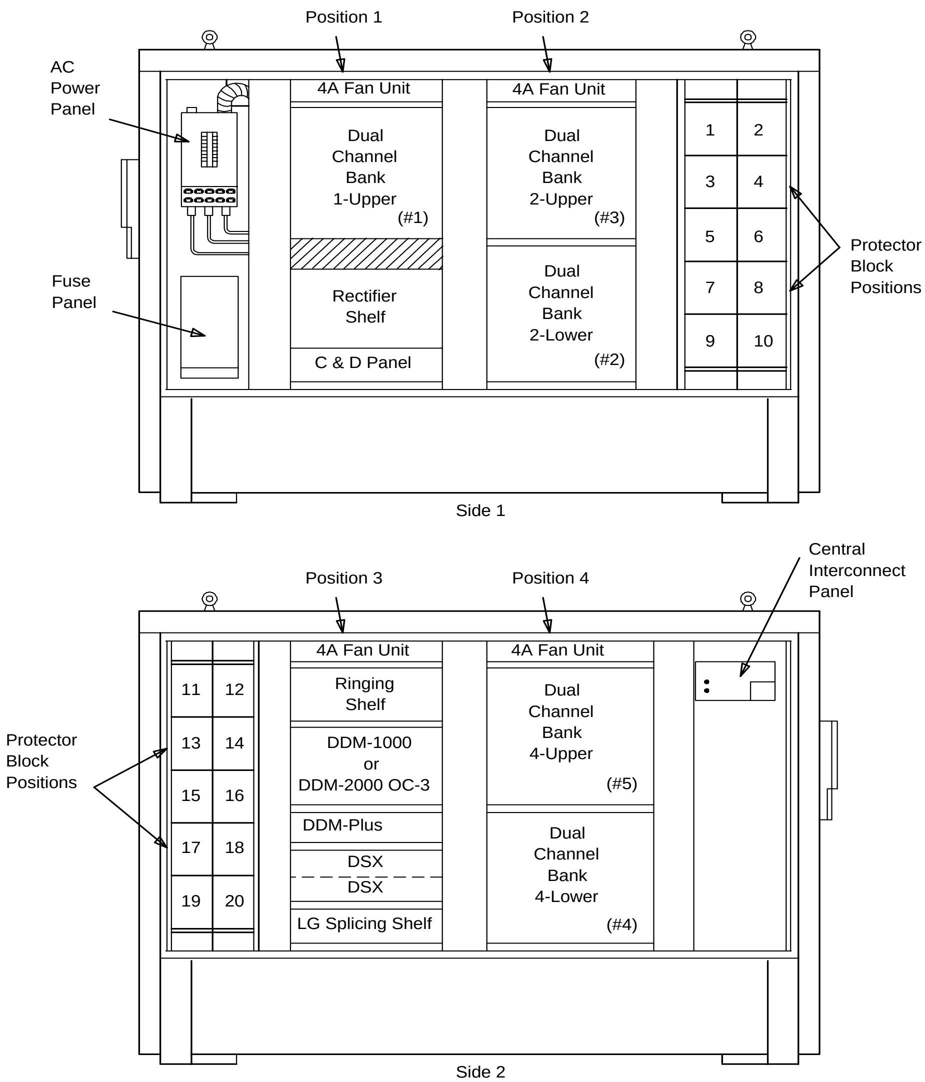


Figure 6-50. 80D Bulk Power Cabinet

For larger OC-3 applications, an 80E bulk power cabinet (Figure 6-52) with seven *SLC* series 5 carrier system dual channel banks (1344 voice-frequency lines) and a DDM-Plus shelf (28 T1 or 7 quad DS1 optical interfaces) is available. Optionally, the seventh channel bank can be replaced by one or two DDM-Plus shelves. The 80E Cabinet will be replaced by the 80G bulk power cabinet for DDM-2000 OC-3 applications with capacity for eight *SLC* Series 5 dual channel banks (1536 voice frequency lines) and a DDM-Plus shelf. Also available for smaller OC-3 applications is an 80A bulk power cabinet (Figure 6-51) with two *SLC* Series 5 carrier system dual channel banks (384 voice-frequency lines) and a DDM-Plus shelf (28 T1 or 7 quad DS1 optical interfaces).

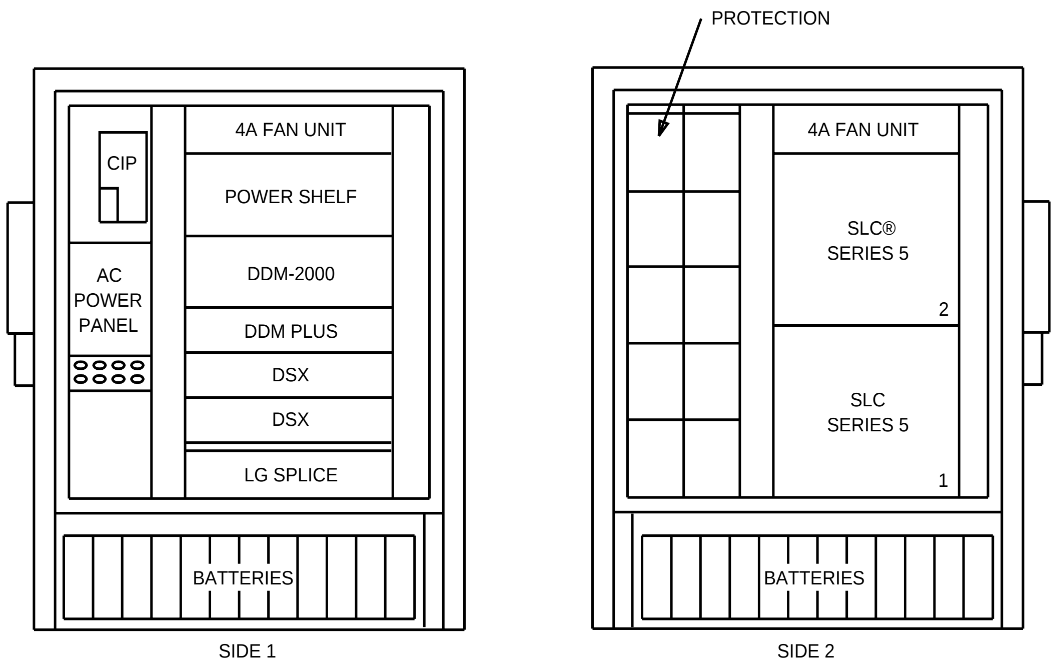


Figure 6-51. 80A Bulk Power Cabinet

For higher capacity applications, the DDM-2000 OC-12 Multiplexer is available in either the 80A, 80D, or 80E bulk power cabinets. These cabinet arrangements can be engineered and precabled to support in-service upgrades from the OC-3 to the OC-12 line rate through the field installation of the DDM-2000 OC-12 Multiplexer.

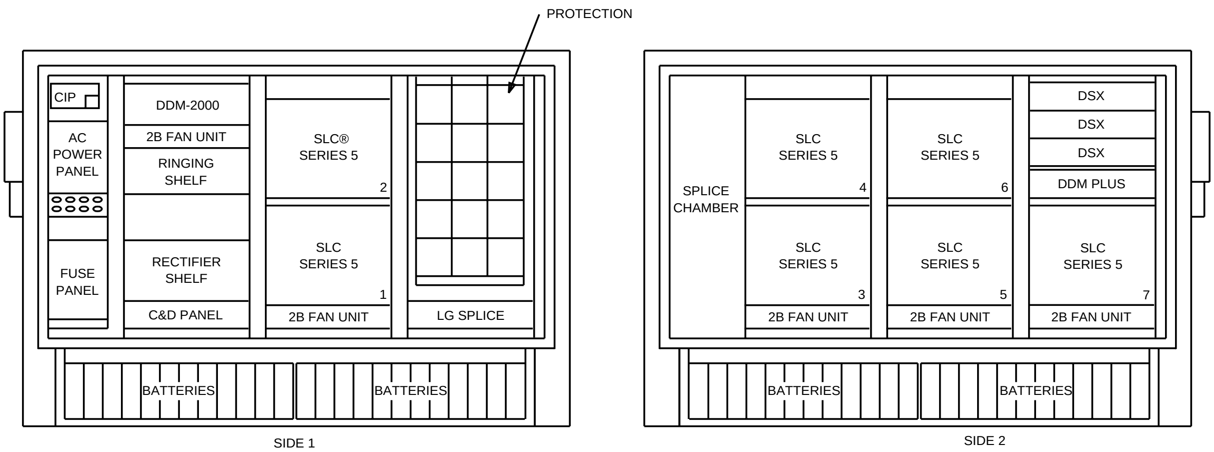


Figure 6-52. 80E Bulk Power Cabinet

The 90A BRT-2000 cabinet (Figure 6-53) supplies up to 192 VF lines and optionally up to 56 DS1 extensions from a customer location cabinet. Other BRT-2000 cabinets will include OC-12 upgrade packages with the DDM-2000 OC-12 Multiplexer.

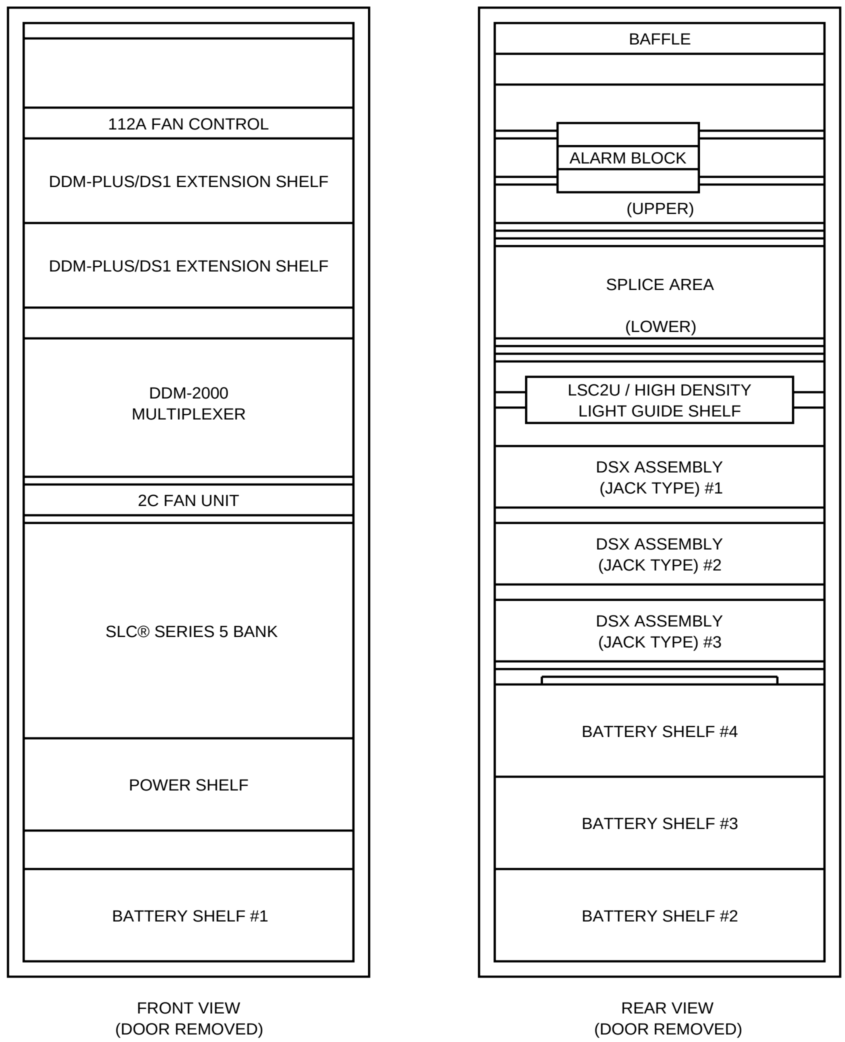


Figure 6-53. 90A BRT-2000 Cabinet

The 51A cabinet, a compact outside plant cabinet (Figure 6-54), supports one DDM-2000 OC-3 Multiplexer with one DDM-Plus shelf.

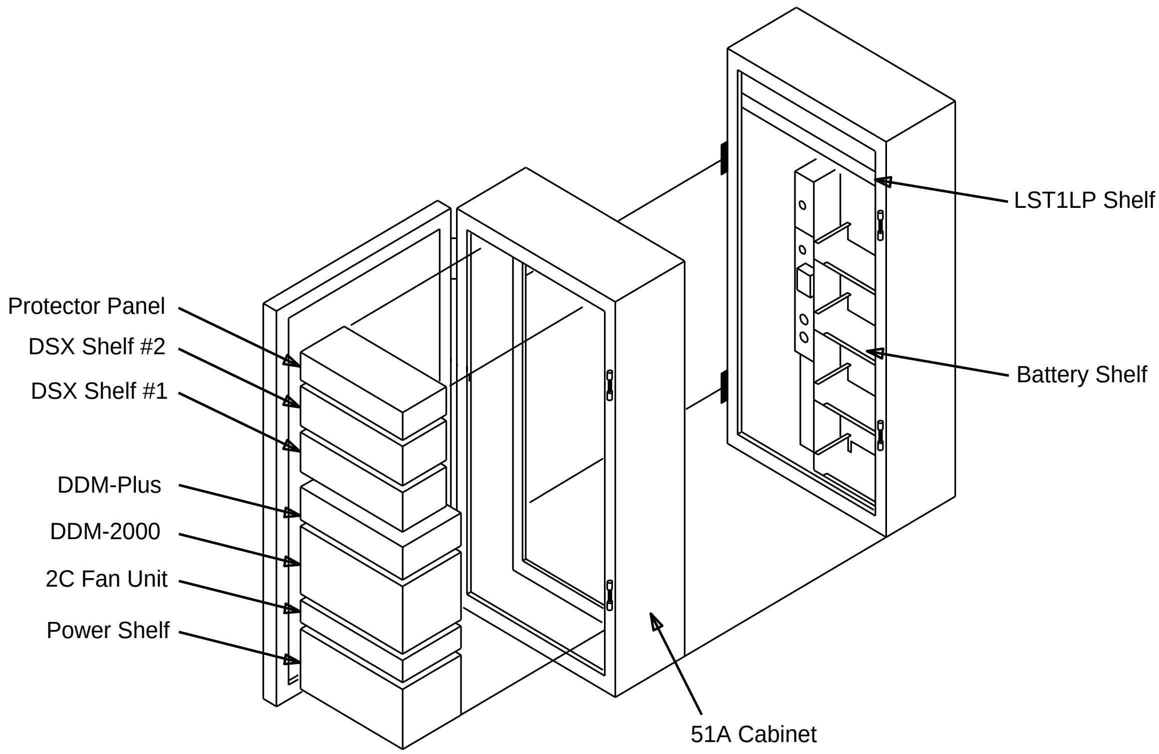


Figure 6-54. 51A Cabinet

Cabling

All the interfaces to the DDM-2000 OC-3 and OC-12 Multiplexers are connectorized. Both front and rear access cabling are available.

Twenty-six gauge (1249C) and 22 gauge (613C) cabling options are available to interface the DDM-2000 OC-3 Multiplexer to a DSX-1 cross-connect bay. For ease of installation, 26 gauge (1249C) cabling is recommended for interfacing the DSX-1 cross-connect bay unless prohibited due to distance requirements. The DSX-3 cabling options include the 734D and 735A coaxial cables. Section 7, "OC-3 Ordering," Section 8, "OC-12 Ordering," and Section 11, "Technical Specifications," provide more details on these options.

Environmental Specifications

The DDM-2000 OC-3 and OC-12 Multiplexers meet the applicable standards for use in CO and uncontrolled environments, electromagnetic compatibility (EMC) requirements, and fire resistance. Complete specifications are in Section 11, "Technical Specifications."

OC-3 Ordering

7

Table of Contents

Table of Contents

OC-3 Ordering

7

Overview

This section provides equipment and software ordering information for the DDM-2000 OC-3 Multiplexer and contains cabling order information for combined bays of the DDM-2000 OC-3 and OC-12 Multiplexers.

Record of Changes

Changes are with respect to the previous version of this document, 363-206-200, Issue 9, dated October 1999, and includes changes related to new cable ordering. These changes include:

- Added information for new cable groups
- Added information for new equipment codes and groups
- Updated references to cable drawings (TOCs, new figure references)

Introduction

This section is designed to facilitate the equipment engineer's job when issuing a telephone equipment order (TEO). It is not intended to replace standard engineering documentation; for example, schematic drawings, equipment drawings, etc. Although not required as a part of a DDM-2000 OC-3 Multiplexer order, if used, this section will ensure that all elements of the DDM-2000 OC-3 Multiplexer and related interfaces arrive and are installed on schedule to assure the timely turnup of DDM-2000 OC-3 Multiplexer equipment.

This section has four major tabs covering ordering information for DDM-2000 OC-3 Multiplexer shelves and cabling, including combined bays of the DDM-2000 OC-3 and DDM-2000 OC-12 Multiplexers (OC-3 Ordering tab), software (Software Ordering tab), plug-ins (Plug-Ins tab), and miscellaneous equipment and tools (Miscellaneous Equipment and Tools tab).

Although each shelf is ordered separately and may be mounted as a stand-alone or miscellaneous mount item, suggested typical bay arrangements are provided per ED-8C724-10 that give complete engineering information that fits traditional central office design criteria. See Sheet 2 of the OC-3 Rear Access cabling drawings (Figures 7-1-1 through 7-1-15) in this section for suggested bay layouts.

DDM-2000 OC-3 Multiplexer equipment is also available in all the traditional loop enclosure arrangements such as described in Section 3, "Applications". Ordering information and references to loop documentation supporting these arrangements are provided in 363-205-000, *SLC® Series 5 Carrier System Ordering Guide*.

The DDM-2000 OC-3 Multiplexer shelf is completely connectorized; thus, when bay cabling is installed on an initial order, shelf additions are made simple for local technicians without the need for installation forces, thereby deferring costs to a point just prior to service needs. Since shelves, standardized cable assemblies, and plug-ins are stocked, order turnaround is substantially reduced for most common arrangements.

Completing an Order Blank

Complete the appropriate order blank:

- Shelf Order Blank
- Appropriate Cable Order Blanks
- Plug-In Order Blank
- Miscellaneous Equipment and Tools Table

Shelf and Cable Ordering

Software Ordering

OC-3 Plug-Ins

Miscellaneous Equipment and Tools

These blanks may be reproduced for order placement. This section requires the entering of quantities or other data to assist in the engineering of the job. Only those blanks pertaining to this particular order should be attached to the order sheet (tables and cable order blanks).

Shelf and Cable Ordering

This section provides cable, shelf, and bay ordering information for DDM-2000 OC-3 Multiplexer arrangements including combined OC-3/OC-12 bays.

DDM-2000 OC-3 Shelf Assembly, ED-8C724-30, G4 Ordering

A single DDM-2000 OC-3 Multiplexer shelf assembly, ED-8C724-30, G4, is all that is required to accommodate a wide variety of network applications. The shelf will support DS1, DS3, EC-1, OC-3, OC-3c, IS-3, and OC-12 interfaces. Feature enhancements are ongoing through the simple addition of new plug-ins without the need for shelf modifications. Some of these future arrangements may require new or changed cabling interfaces; however, for bay arrangements—where plans are known—it may be prudent to include this cabling on initial orders to facilitate later installations.

When used as a DDM-2000 FiberReach host (Release 9.0 and later), the G1 or G3 shelf requires BBF5 jumper circuit packs in the appropriate low-speed slots. The G4 shelf is now available replacing the G1 or G3 shelf for new applications. The G4 shelf can replace the G1 or G3 shelf in all applications and does not need the BBF5 jumper circuit packs for DDM-2000 FiberReach host applications.

When using a G3 shelf as the FiberReach host or with the 24G-U/24H-U or 29G-U/29H-U OC-12 interface, the G3 to G4 upgrade kit is also required. This kit (847544177) provides a deeper front cover for fiber clearance when using the 27G/27G2-U or 24G-U/24H-U or 29G-U/29H-U OLIUs.

When using the G4 shelf with the alternative isolated grounding scheme, the BBG8B SYSCTL is required. The G4 shelf may be used with a traditional grounding scheme with any system controller circuit pack.

Table 7-1 and associated cable order blanks, completed with the help of the appropriate cable drawings, provide an ordering package for a single DDM-2000 OC-3 shelf and all the cabling interfaces. For single shelves, the bottom shelf arrangement in Figure 7-1-1 should be used.

DDM-2000 OC-3 ED-8C724-30, G4 Shelf Orders for Central Office Bay Arrangements

Although DDM-2000 OC-3 shelves are normally ordered as stand-alone entities, typical bay arrangements can be locally engineered and installed per Figure 7-1-1.

T1 Lightning and Surge Secondary Protection Assembly, ED-8C783-30

Since T1 or HDSL digital lines may be exposed to lightning power surges and power crosses in outside plant applications, an external secondary lightning and surge protection assembly, ED-8C783-30, is required with all outside plant T1 or HDSL applications. This assembly is mounted externally to the DDM-2000 OC-3 shelf and can be installed in racks or cabinets. The assembly can hold up to 14 LPROT cards. Enough to protect 14 T1 or HDSL digital lines. Two LPROT lightning protection cards must be ordered for each BBF6 T1EXT or BBF8 HDSL circuit pack that is ordered. The lightning and surge protection assembly is for secondary protection only. The tip and ring conductors must have gas tubes (Lucent Technologies' protector unit 4B3EW or equivalent) installed at the point of entry into a cabinet or building.

Typical Bay Arrangements for DDM-2000 OC-3 Optical Networks

Figure 7-1-1 provides a typical bay arrangement (ED-8C724-10) for up to six OC-3 SONET-configured shelves. This arrangement meets network equipment-building system (NEBS) central office requirements for bay heat dissipation. Although additional space is available in the bay, it should not be used for miscellaneous equipment if the NEBS requirements are to be met. In addition, if other than the typical arrangements are used, normal heat flow could be interrupted and adversely affect shelf operation. Heat baffles must be placed as indicated to guarantee proper air circulation. Although the typical bay figures reflect 7-ft. bay arrangements, 9-ft. or 11-ft. 6-in. bays may be used providing the shelf arrangements are identical to those shown for the 7-ft. arrangements.

A standard 7-foot fully-loaded bay arrangement may contain six DDM-2000 OC-3 Multiplexers. This arrangement (ED8C906-30) can be configured with either front or rear access cabling (with or without a fuse panel) and supports the full set of the OC-3 upgrade capabilities. For applications where a future upgrade to OC-12 is expected, a 7-foot bay arrangement also supports four DDM-2000 OC-3 Multiplexers plus the DDM-2000 OC-12 Multiplexer or three DDM-2000 OC-12 shelves. Refer to Table 7-2, Page 7-9 for ordering information.

The DDM-2000 OC-12 Multiplexer can be mounted stand-alone in an ED-8C500 bay with front and rear access cabling. A standard 7-foot bay arrangement contains three DDM-2000 OC-12 Multiplexers.

The DDM-2000 OC-3 Multiplexer does not require fans in central office environments.

In uncontrolled environments, if the air inlet temperature is above 50°C, fan shelves must be installed per ED-8C724-10.

Shelves can be added incrementally by local technicians (since all cabling is connectorized) providing that interbay cabling is initially provided for the bay layout. If shelves are incrementally installed, it is recommended that they be installed in position number sequence as shown in Figure 7-1-1 to simplify bay mult cabling; however, shelves may be added in any position so long as proper bay mult cabling is selected. There is one exception. The first shelf installed should be installed in Position 1. Also, if using parallel telemetry, shelf ID administration could be a problem if shelves are not added sequentially. Shelf interbay cabling may also be ordered for shelves that are to be added at a later date.

Table 7-1. OC-3 Shelf Order Blank

(Provide one blank per shelf ordered)

Qty Ord	Equipment Code	Equipment Furnished with Group Ordered					Description
		Shelf	Shelf w/Manual	Heat Baffle	Fan Assy	See Note	
	ED-8C724-30,G4	1				1	DDM-2000 OC-3 Shelf
	ED-8C724-30,G4,B		1			1,2	DDM-2000 OC-3 Shelf
	ED-8C724-30,G4,D		1			1,3	DDM-2000 OC-3 Shelf
	ED-8C724-30,G4,E		1			1,4	DDM-2000 OC-3 Shelf
	ED-8C733-30,G1			1		5	Baffle
	ED-8C733-30,G7				1	5	Fan Assembly
	847554177					6	G3 to G4 Cover Upgrade Kit
	ED-8C783-30, G2					7	DDM-2000 Secondary Lightning and Surge Protection Assembly equipped with 2 backplanes
	105419428 (807AS Cable					8	Interface cable for Lightning and Surge Protection Shelf
	ED-8C724, G4, F		1			1, 9	DDM-2000 OC-3 shelf

Notes

1. See Plug-Ins tab for examples of shelf plug-in arrangements. Included with each ED-8C724-30, G4 shelf is hardware (required for bay mounting).
2. Equipment Code B adds a *363-206-202, DDM-2000 OC-3 Multiplexer User/Service Manual* for Releases through 7.x.x. The user/service manual can also be ordered using the software ordering blank in the "Software Ordering" section.
3. Equipment Code D adds a *363-206-280, DDM-2000 OC-3 Multiplexer User/Service Manual* for Releases 8.x, 9.0, 9.1 and 11.x. The user/service manual can also be ordered using the software ordering blank in the "Software Ordering" section.
4. Equipment Code E adds a *363-206-285, DDM-2000 OC-3 Multiplexer User/Service Manual* for Releases 13.0 and higher. The user/service manual can also be ordered using the software ordering blank in the "Software Ordering" section.

5. A heat baffle assembly should be ordered with each shelf assembly except for the top shelf in a 7-ft. bay arrangement. When the 7-ft. layout is mounted in 9-ft. or 11-ft. 6-in. bays, a baffle should also be ordered for the top shelf (see ED-8C724-10 for complete bay assembly information). See Sheet 2 of the OC-3 Rear Access cabling drawings (Figure 7-1-1) in this section for suggested bay arrangements. **The DDM-2000 OC-3 Multiplexer does not require fans in central office environments**. In uncontrolled environments, for single shelf arrangements, if the air inlet temperature is above 50°C, a fan shelf must be used in place of a heat baffle. For similar conditions in bay arrangements, fan shelves must be installed per ED-8C724-10.
6. This upgrade kit primarily provides a deeper cover to the OC-3 ED8C724-30 G3 shelf only to accommodate the 27G-U/27G2-U OLIU, which is required for FiberReach applications, the 24G-U/24H-U or 29G-U/29H-U OLIU, which supports the OC-12 interface, and the BBG19 Data Interface.
7. The secondary lightning and surge protection assembly is mounted externally to the DDM-2000 OC-3 Shelf. Two backplane assemblies protect up to seven T1EXT or HDSL circuit packs. Cabling for this assembly is ordered separately.
8. T1 and HDSL interface and DSX interface cables to Lightning and Surge Protection Shelf. Cable length must be specified. Four cables are required for each additional shelf.
9. Equipment Code F adds a 300-100-015 DDM-2000 User/Service Manual on CD-ROM.

Table 7-2. OC-3/OC-12 Bay Order Blank

(Provide one blank per bay ordered)

Qty Ord	Equipment Code	Comcode	Equipment Drawing	Description
	ED-8C906-30, G1	601930985	ED-8C906-30	7 Ft. Bay Equipped with 6 DDM-2000 OC-3 Shelves (without Apex Fuse Panel)
	ED-8C906-30, G2	601931009	ED-8C906-30	7 Ft. Bay Equipped with 6 DDM-2000 OC-3 Shelves (with Apex Fuse Panel)
	ED-8C906-30, G3	601931025	ED-8C906-30	7 Ft. Bay Equipped with 4 DDM-2000 OC-3 Shelves and 1 DDM-2000 OC-12 Shelf (without Apex Fuse Panel)
	ED-8C906-30, G4	601931033	ED-8C906-30	7 Ft. Bay Equipped with 4 DDM-2000 OC-3 Shelves and 1 DDM-2000 OC-12 Shelf (with Apex Fuse Panel)
	ED-8C906-30, G5	601931041	ED-8C906-30	7 Ft. Bay Equipped with 3 DDM-2000 OC-12 Shelves (without Apex Fuse Panel)
	ED-8C906-30, G6	601931058	ED-8C906-30	7 Ft. Bay Equipped with 3 DDM-2000 OC-12 Shelves (with Apex Fuse Panel)
	ED-8C906-30, G7	601973837	ED-8C906-30	7 Ft. Bay Equipped with 6 DDM-2000 OC-3 Shelves (with Apex Fuse Panel) in a gray bay frame
	ED-8C906-30, G8	601973845	ED-8C906-30	7 Ft. Bay Equipped with 4 DDM-2000 OC-3 Shelves and 1 OC-12 Shelf (with Apex Fuse Panel) in a gray bay frame
	ED-8C906-30, G9	601973852	ED-8C906-30	7 Ft. Bay Equipped with 3 DDM-2000 OC-12 Shelves (with Apex Fuse Panel) in a gray bay frame

DDM-2000 OC-3 Rear Access Cabling

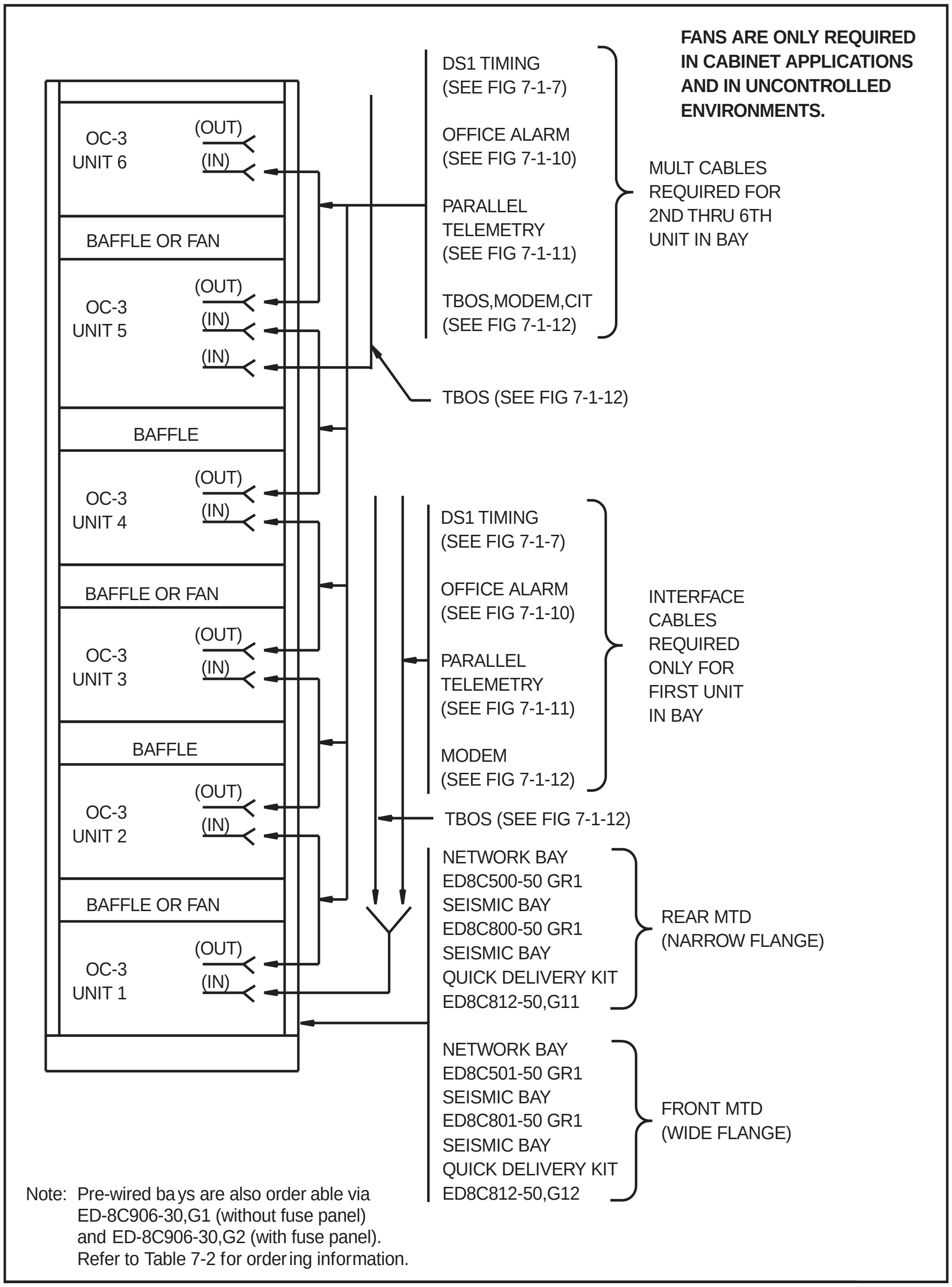


Figure 7-1-1 Typical Bay Arrangement for DDM-2000 OC-3

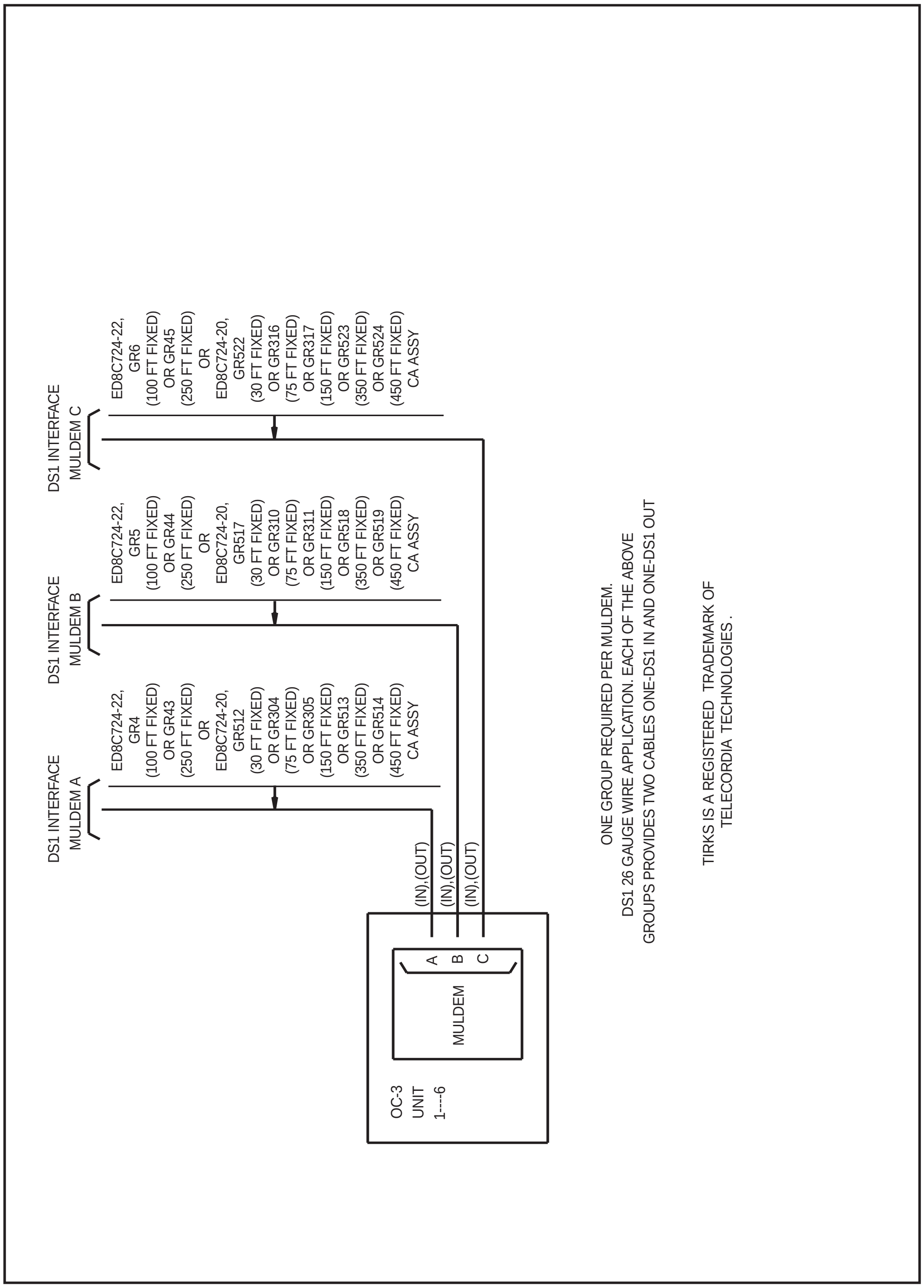


Figure 7-1-2 DS1 Transmission Cables — 26 Gauge

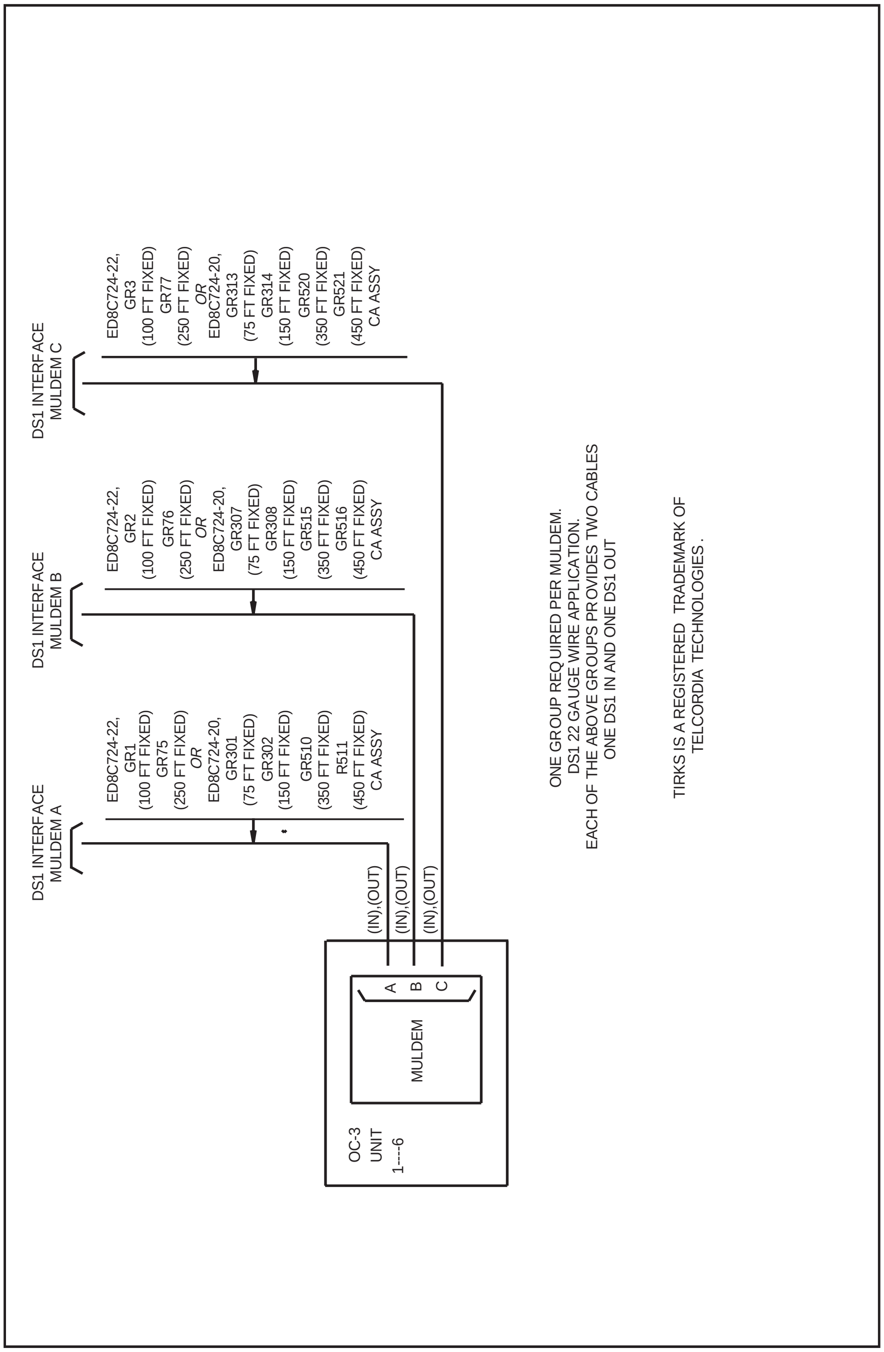


Figure 7-1-3 DS1 Transmission Cables — 22 Gauge

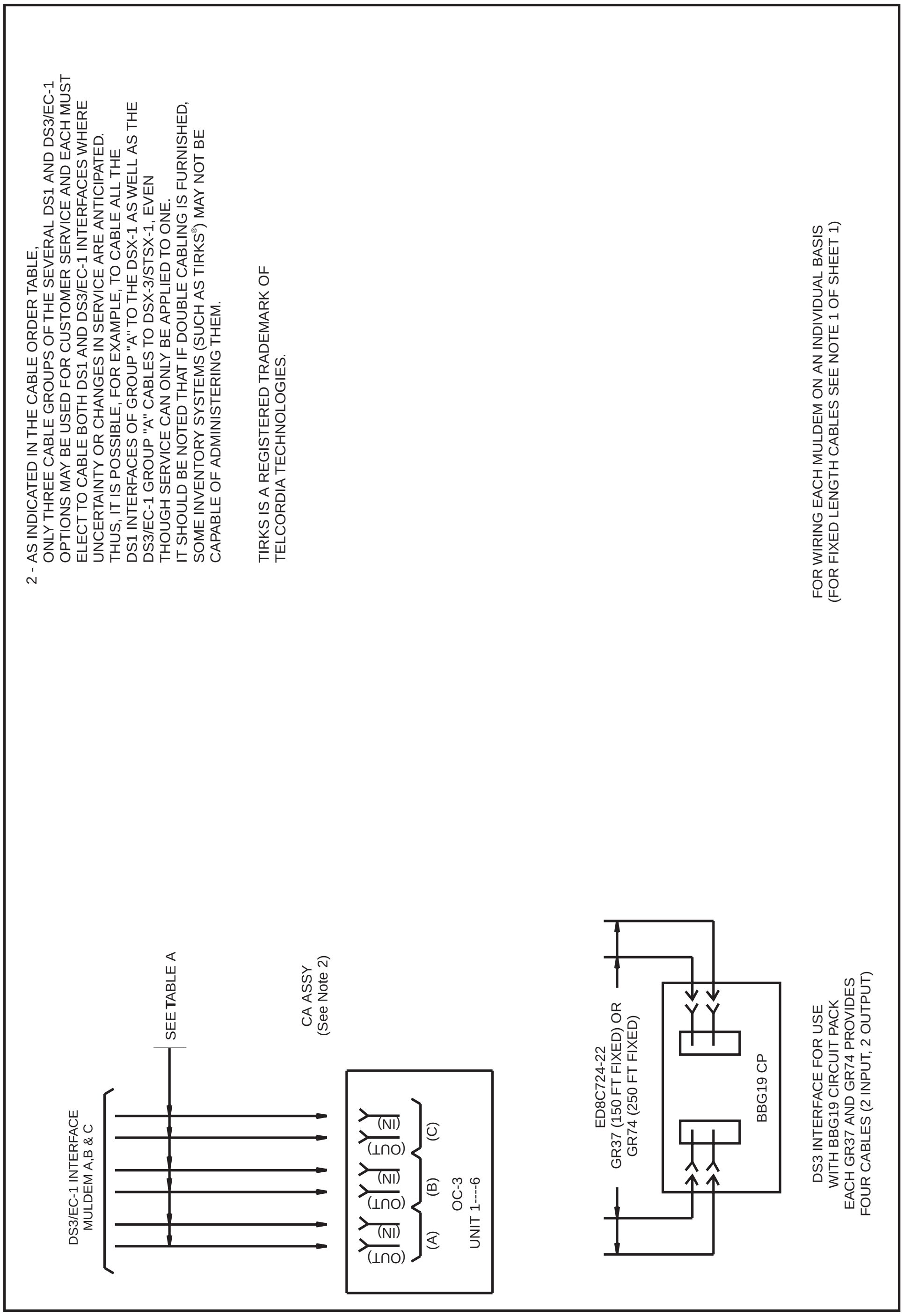


Figure 7-1-5 DS3/EC-1 TRANSMISSION CABLE

Figure 7-1-4 DS3/EC-1 Transmission Cable

TABLE A (OC-3 COAXIAL CABLE APPLICATIONS FOR REAR ACCESS)

APPLICATION		CABLE TYPE***		ED8C900-12*	MAXIMUM LENGTH	REMARKS
DSX-3,DSX 3/4, STSX-1		735A (BNC-BNC)†			250 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC)†			250 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC)†			450 FT MAX	MAX SIX CABLES PER SHELF
DACS III-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC)†			500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC)†			500 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC)†			900 FT MAX	MAX SIX CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821AE-BNC)‡			500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (9821AE-BNC)‡			500 FT MAX	ONE CABLE PER SHELF **
		734D (9821AE-BNC)‡			900 FT MAX	MAX SIX CABLES PER SHELF
DACS IV-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC)†			500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC)†			500 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC)†			900 FT MAX	MAX SIX CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A	(9821EA-BNC) ‡ (OUT)		500 FT MAX	THREE CABLES MAX PER SHELF
			(9821FA-BNC) ‡ (IN)			THREE CABLES MAX PER SHELF
		1735006A (9821EA/FA-BNC)‡			500 FT MAX	ONE CABLE MAX PER SHELF
		734D	(9821EA-BNC) ‡ (OUT)		900 FT MAX	THREE CABLES MAX PER SHELF
			(9821FA-BNC) ‡ (IN)			THREE CABLES MAX PER SHELF

* - ED-8C900-12 HAS REPLACED ED-8C900-20 FOR ALL DS3/EC-1 ORDERING.
CABLES IN THIS DRAWING ARE SORTED BY CONNECTOR TYPES.
** - EACH 1735006A CABLE CONTAINS 6 COAXIAL CABLES WITH ASSOCIATED CONNECTORS.
*** - BNC CONNECTORS ARE SHIPPED LOOSE WITH CABLE.
† - STRAIGHT AND RIGHT ANGLE
‡ - RIGHT ANGLE ONLY

Figure 7-1-5 DS3/EC-1 Transmission Cable

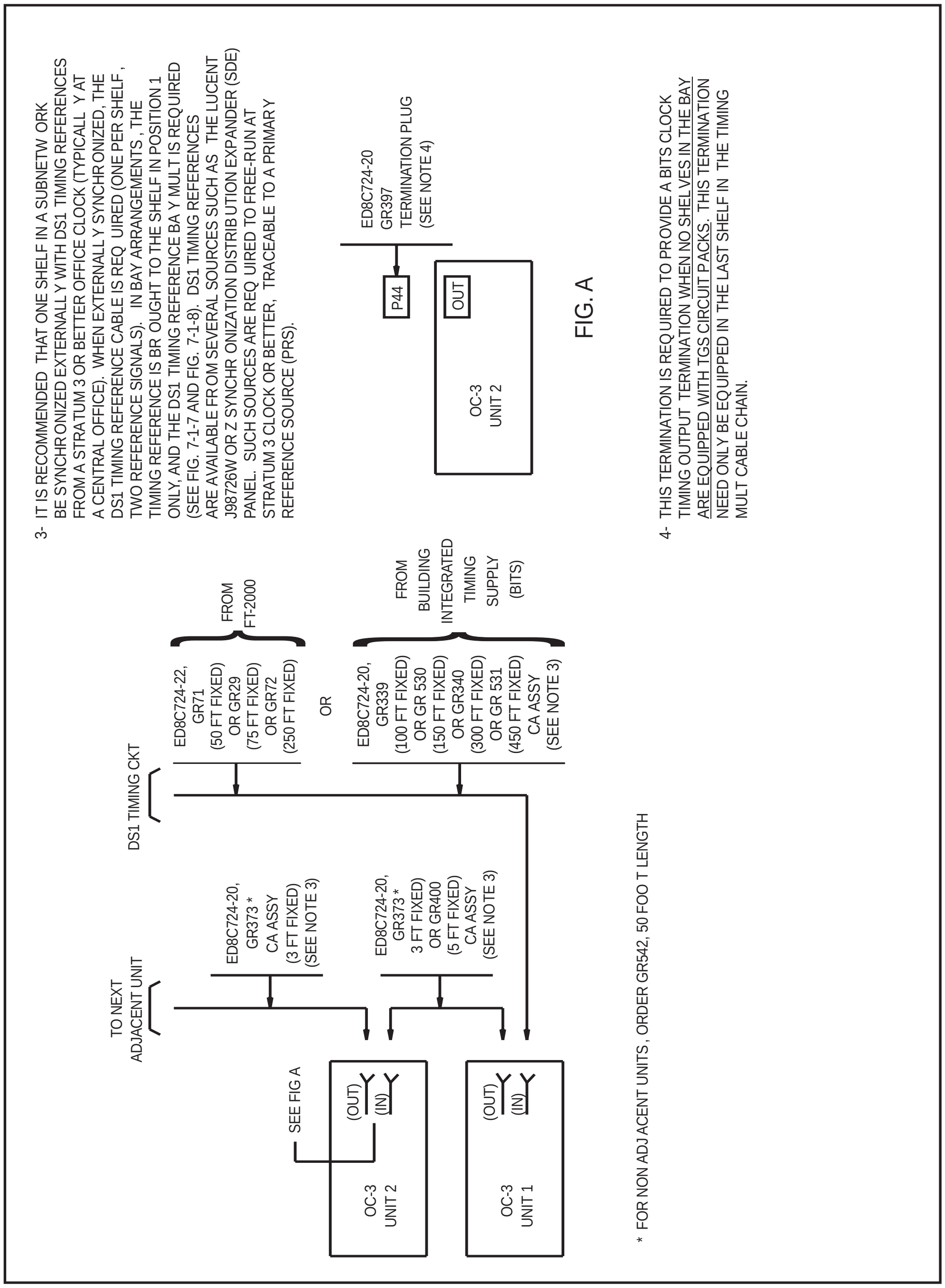


Figure 7-1-6 DS1 Timing Reference Interface and Mult Cable

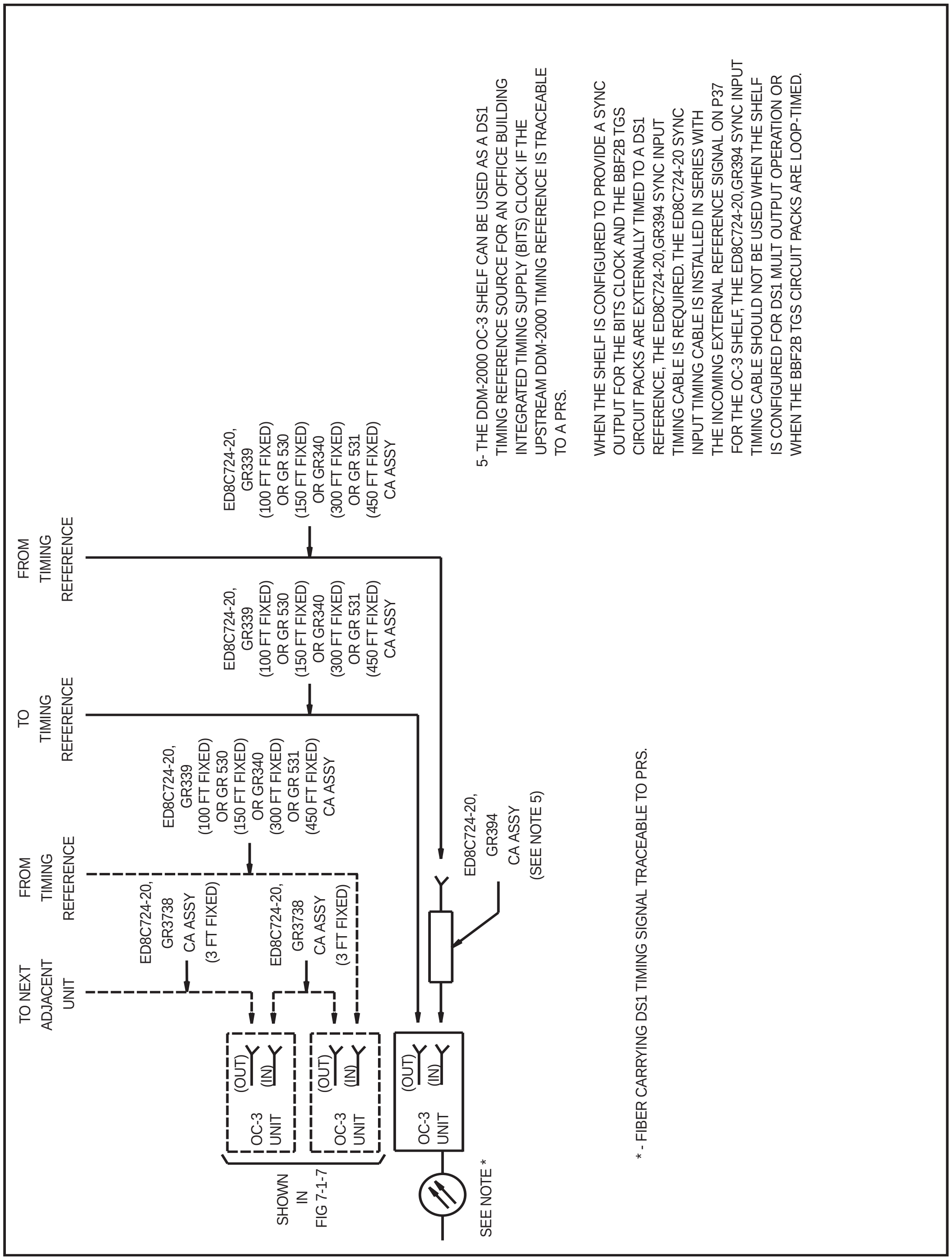


Figure 7-1-7 Synchronization for Timing Distribution Cable in a Bay Arrangement

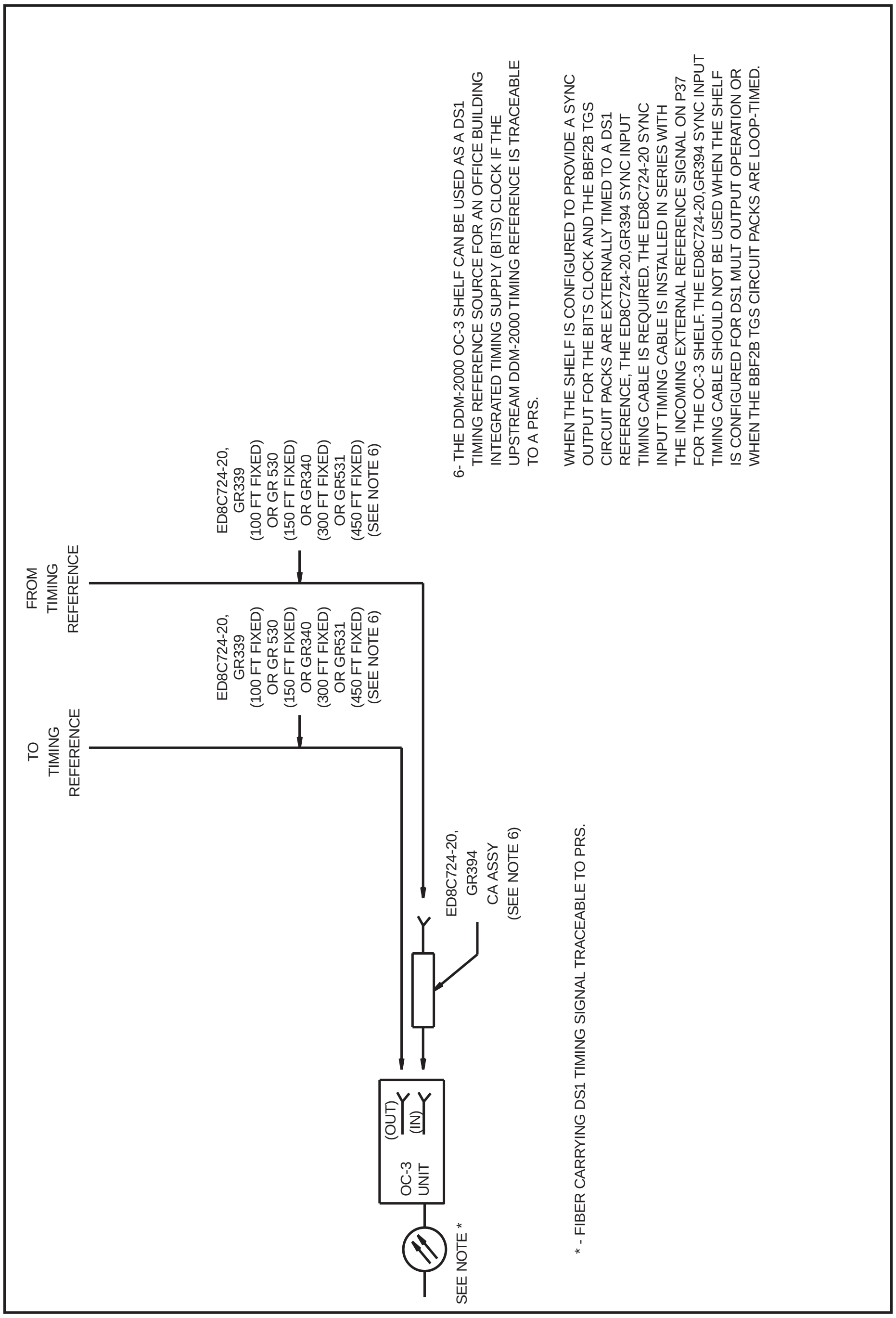


Figure 7-1-8 Synchronization for Timing Distribution Cable in a Single Shelf Assembly

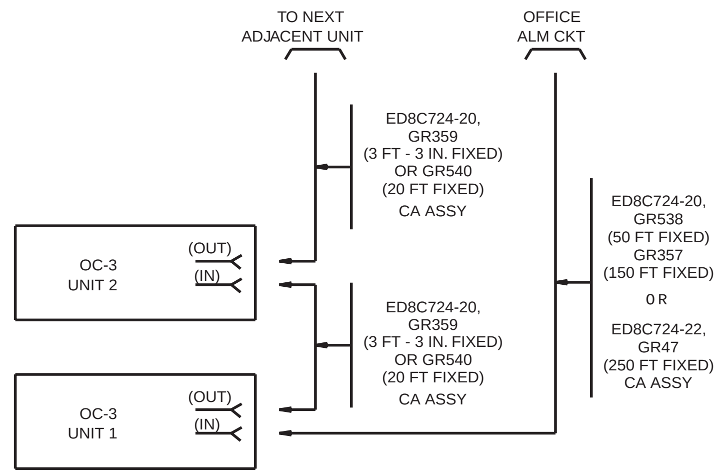


Figure 7-1-9 Office Alarm Interface and Mult Cable

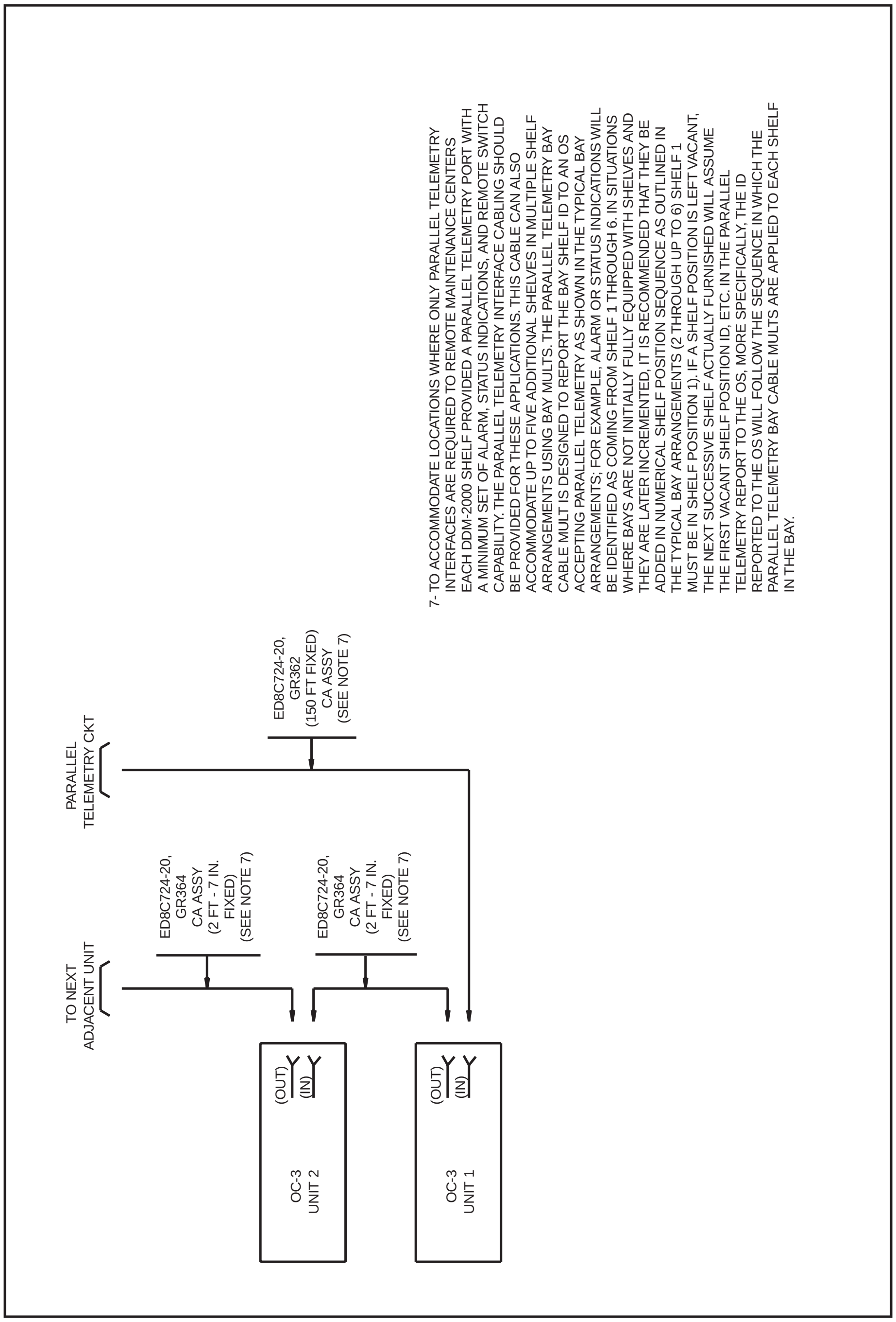


Figure 7-1-10 Parallel Telemetry Interface and Mult Cable

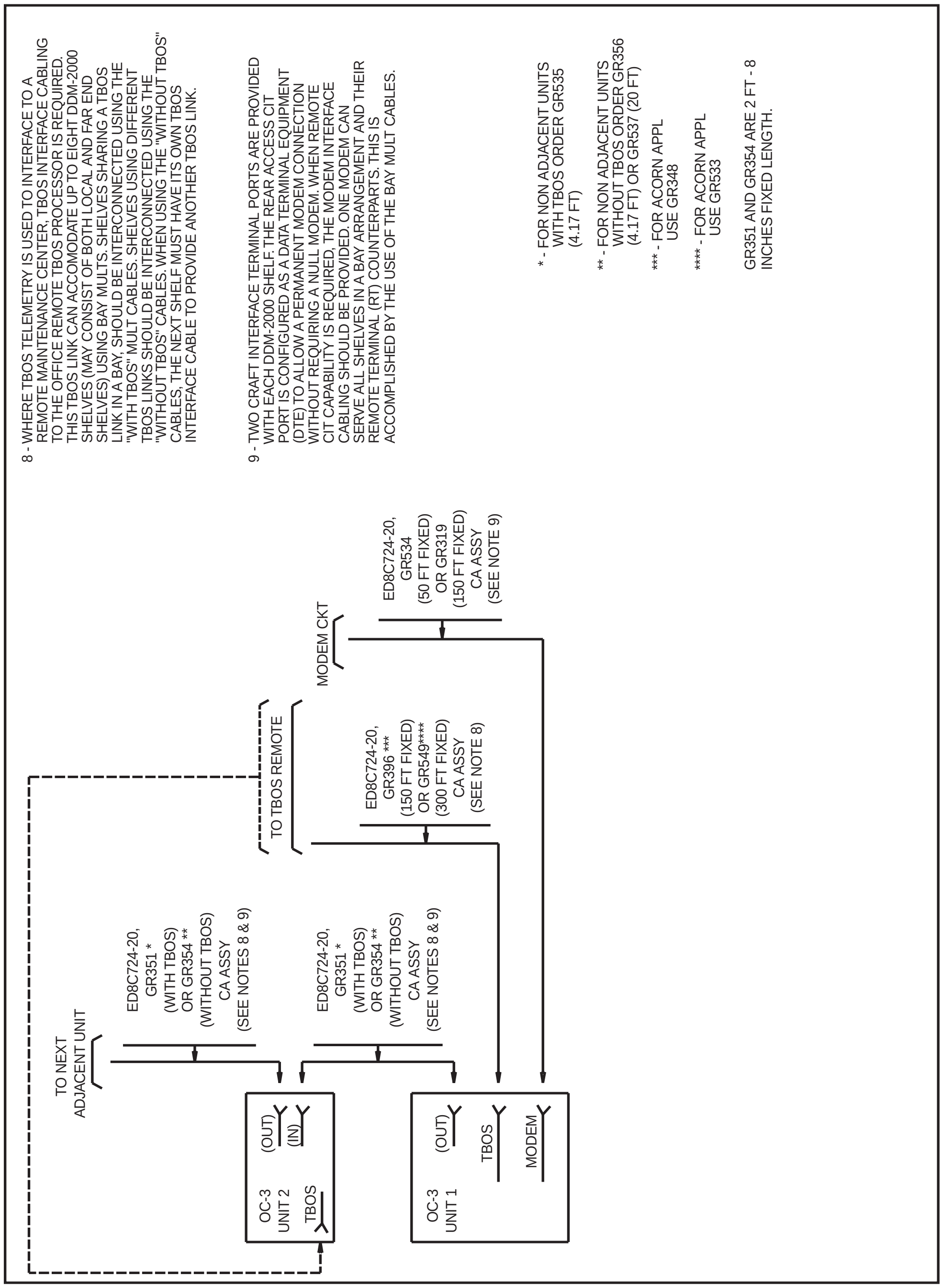


Figure 7-1-11 Modem, TBOS Interface and Bay Mult Cable for TBOS, CIT, and Modem

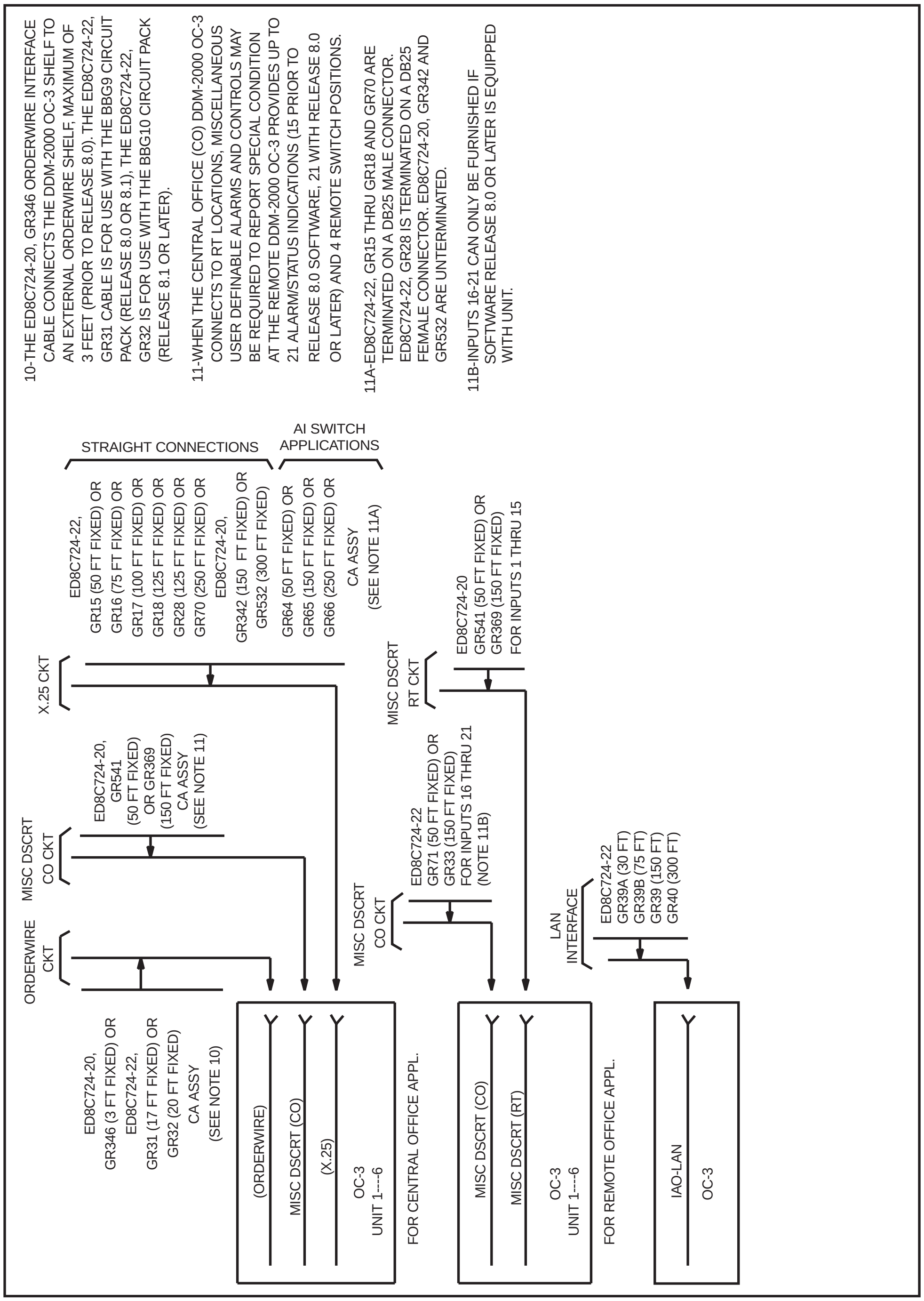


Figure 7-1-12 X.25 Interface, Miscellaneous Discretes, Orderwire, and LAN

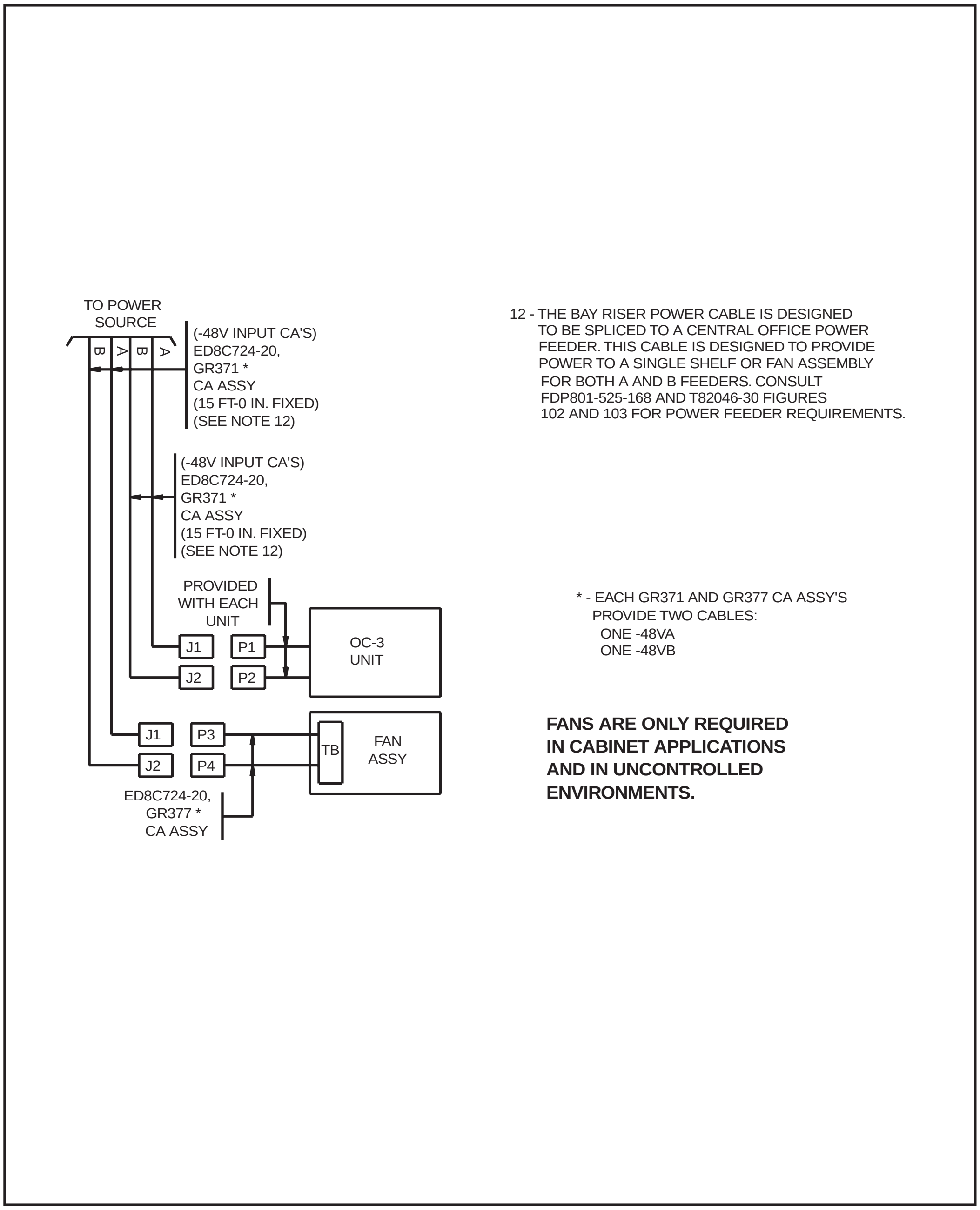


Figure 7-1-13 Power for Single OC-3 Unit and Fan Assembly

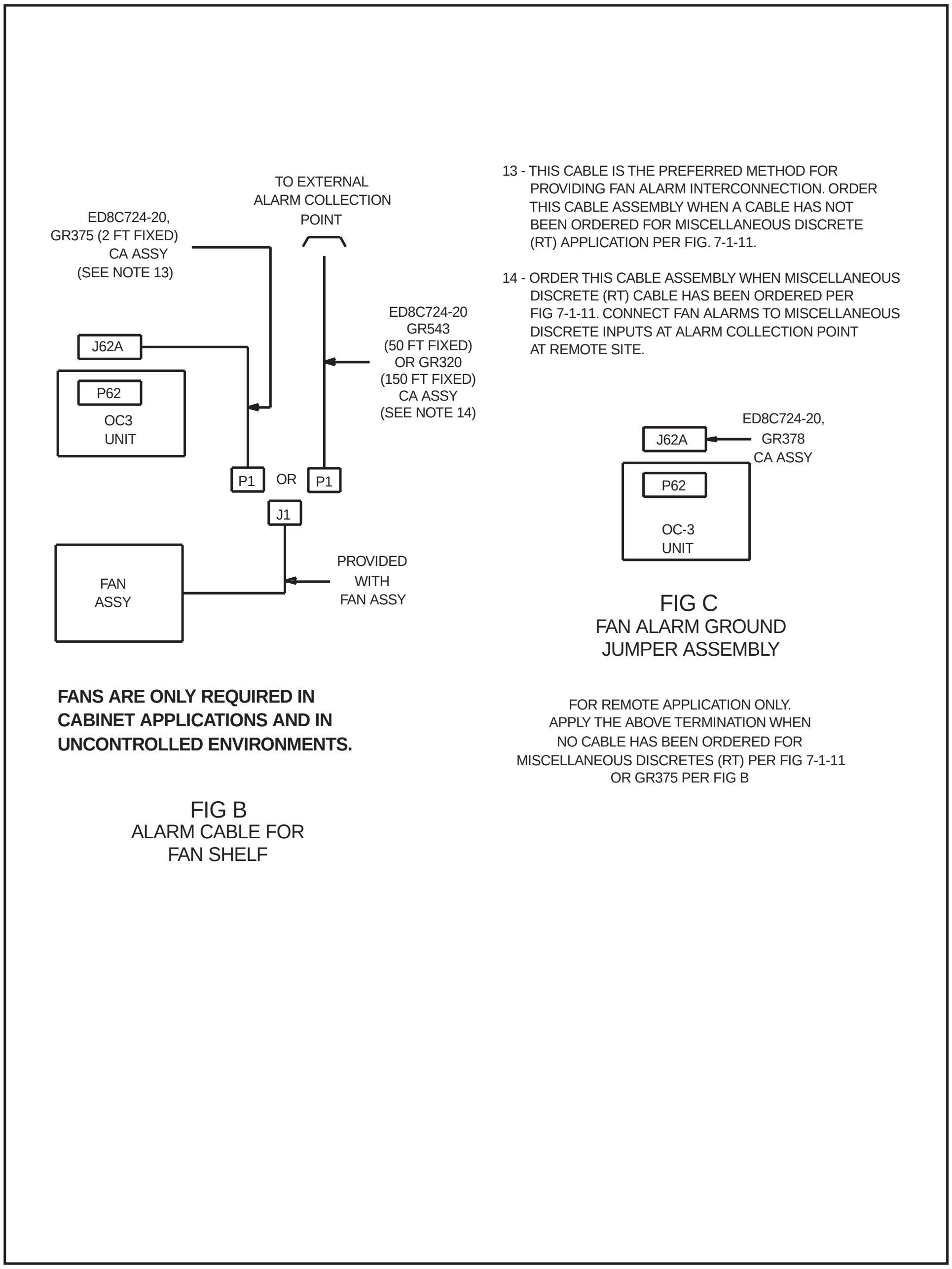


Figure 7-1-14 Alarm Cable for Fan Shelf and Fan Alarm Ground Jumper Assembly

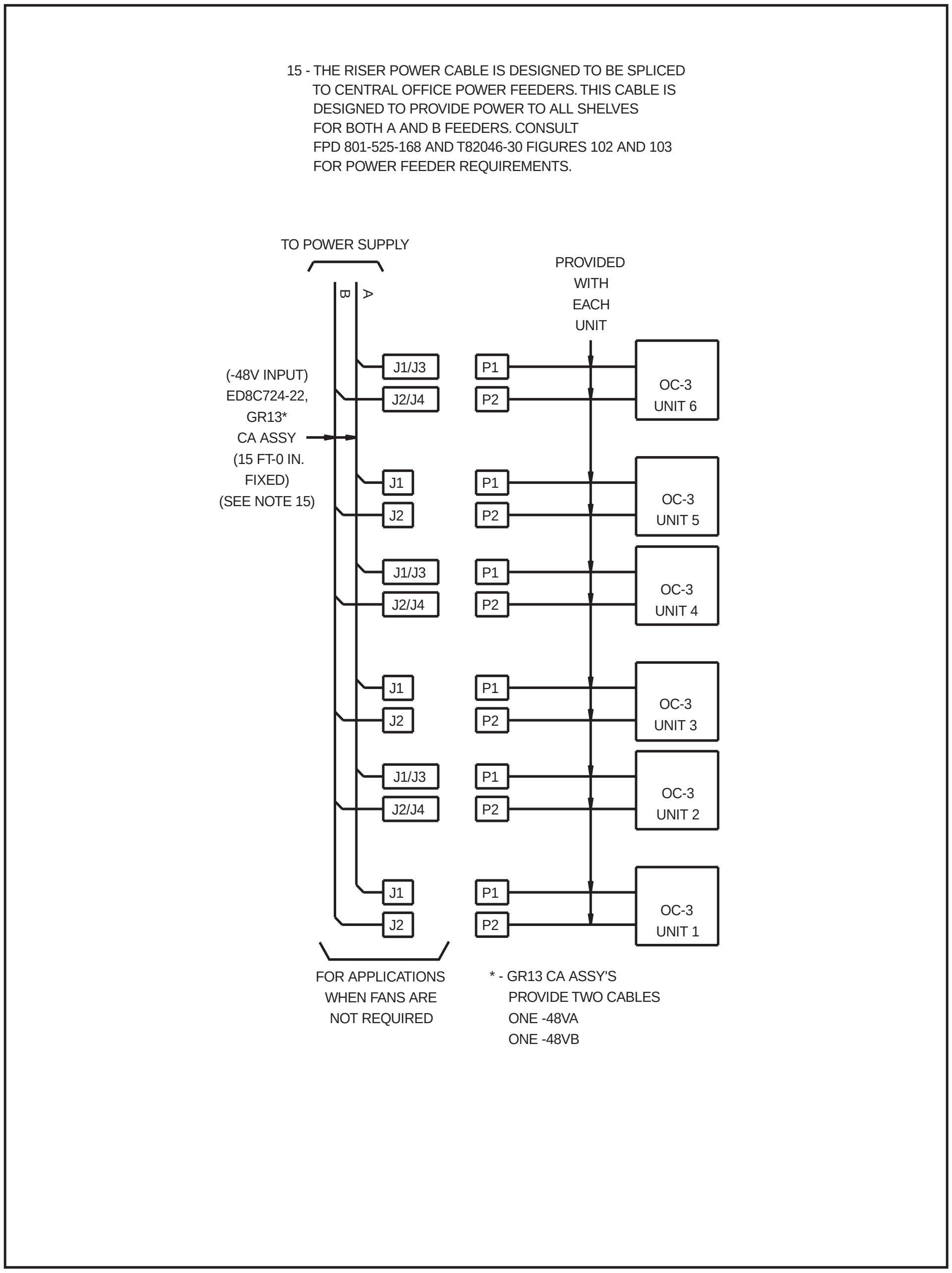


Figure 7-1-15 Power Input Cable for Bay Arrangement of OC-3 Units Without Fan Assembly

OC-3 REAR ACCESS CABLE ORDER BLANK (SHEET 1 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes	
DS1 26-Gauge Wire Application, One Group Required per MULDEM	7-1-2	ED8C724-22	4 or	100	1	1		DS1 Interface MULDEM A Length ≥ 30 Feet	
	7-1-2		43	250					
	7-1-2	ED8C724-20	304 or	75					
	7-1-2		305 or	150					
	7-1-2		512 or	30					
	7-1-2		513 or	350					
	7-1-2		514	450					
	7-1-2	ED8C724-22	5 or	100	1	1		DS1 Interface MULDEM B Length ≥ 30 Feet	
	7-1-2		44	250					
	7-1-2	ED8C724-20	310 or	75					
	7-1-2		311 or	150					
	7-1-2		517 or	30					
	7-1-2		518 or	350					
	7-1-2		519	450					
	7-1-2	ED8C724-22	6 or	100	1	1		DS1 Interface MULDEM C Length ≥ 30 Feet	
	7-1-2		45	250					
	7-1-2	ED8C724-20	316 or	75					
	7-1-2		317 or	150					
	7-1-2		522 or	30					
	7-1-2		523 or	350					
	7-1-2		524	450					
For DS1 Applications of ≤ 20 Feet	7-1-2	846881621			4	4		MULDEM A, B, or C With Length ≤ 20 Feet (4/MULDEM)	
	7-1-2	ED8C724-21	450		1	1		MULDEM A	Required for Each Application of 846881621
	7-1-2		451		1	1		MULDEM B	
	7-1-2		452		1	1		MULDEM C	

OC-3 REAR ACCESS CABLE ORDER BLANK (SHEET 2 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
DS1 22-Gauge Wire Application, One Group Required per MULDEM	7-1-3	ED8C724-22	1 or	100	1	1		DS1 Interface MULDEM A Length ≥ 30 Feet
	7-1-3		75	250				
	7-1-3	ED8C724-20	301 or	75				
	7-1-3		302 or	150				
	7-1-3		510 or	350				
	7-1-3		511	450				
	7-1-3	ED8C724-22	2 or	100	1	1		DS1 Interface MULDEM B Length ≥ 30 Feet
	7-1-3		76	250				
	7-1-3	ED8C724-20	307 or	75				
	7-1-3		308 or	150				
	7-1-3		515 or	350				
	7-1-3		516	450				
	7-1-3	ED8C724-22	3 or	100	1	1		DS1 Interface MULDEM C Length ≥ 30 Feet
	7-1-3		77	250				
	7-1-3	ED8C724-20	313 or	75				
	7-1-3		314 or	150				
	7-1-3		520 or	350				
	7-1-3		521	450				

OC-3 REAR ACCESS CABLE ORDER BLANK (SHEET 3 OF 8)

Fig. Description	Fig.	Code	Group/ Comcode Num.	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
735A Cable for DS3 Interface with BBG19	7-1-4/ 7-1-5	ED8C724-22	37 or	150	1	1		One Group Required per MULDEM
	7-1-4/ 7-1-5		74	250				
735A Cable for DS3/EC-1 Applications When Wiring Each MULDEM on an Individual Basis	7-1-4/ 7-1-5	ED-8C900-12	108799651* (Table 1V)	150	2	2		Note 1

*Right angle BNC — loose straight BNC.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

OC-3 REAR ACCESS CABLE ORDER BLANK (SHEET 4 OF 8)

Fig. Description	Fig.	Code	Group/ Comcode Num	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
1735006A Cable for DS3/EC-1 Applications When all Three MULDEMs are Wired at the Same Time	7-1-4/ 7-1-5	ED8C900-12	108811845* (Table 4V)	150	1	1		Note 1
734D Cable for DS3/EC-1 Applications When Cable Length Exceeds the 735 Type Cable Requirements	7-1-4/ 7-1-5	ED8C900-12	108818048** (Table 6H)	300	6	6		Notes 1 and 2

* Right angle BNC — loose straight BNC.
** Right angle BNC — no connector.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

Note 2: One end has no connector. Order with comcode 407772235 for straight BNC. See Table 7A from ED-8C900-12 for other connector types.

OC-3 REAR ACCESS CABLE ORDER BLANK (SHEET 5 OF 8)

<table>
<tr><th>Fig. Description</th><th>Fig.</th><th>Code</th><th>Group Num</th><th>Enter Length (Feet) if Reqd</th><th>Qty Reqd for First Unit in Bay</th><th>Qty Reqd for Each Addnl Unit in Bay</th><th>Qty to be Ordered</th><th>Notes</th></tr>
<tr><td rowspan="11">DS1 Timing Input and MULT Cable Required Between Adjacent Units</td><td>7-1-6</td><td>ED8C724-22</td><td>71</td><td>50</td><td></td><td></td><td></td><td rowspan="3">From FT-2000</td></tr>
<tr><td>7-1-6</td><td></td><td>29 or</td><td>75</td><td rowspan="6">1</td><td></td><td></td></tr>
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<tr><td>7-1-6</td><td></td><td>340 or</td><td>300</td><td></td><td></td></tr>
<tr><td>7-1-6</td><td></td><td>530 or</td><td>150</td><td></td><td></td></tr>
<tr><td>7-1-6</td><td></td><td>531</td><td>450</td><td></td><td></td></tr>
<tr><td>7-1-6</td><td></td><td>373 or</td><td>3</td><td></td><td rowspan="3">1</td><td></td><td></td></tr>
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<tr><td>7-1-6</td><td></td><td>397</td><td></td><td></td><td>A/R</td><td></td><td>See Fig. 7-1-6, Fig. A</td></tr>
<tr><td rowspan="9">Synchronization for Timing Distribution Cable in a Bay Arrangement</td><td>7-1-7</td><td>ED8C724-20</td><td>339 or</td><td>100</td><td rowspan="4">2</td><td rowspan="4">1</td><td></td><td></td></tr>
<tr><td>7-1-7</td><td></td><td>340 or</td><td>300</td><td></td><td></td></tr>
<tr><td>7-1-7</td><td></td><td>530 or</td><td>150</td><td></td><td></td></tr>
<tr><td>7-1-7</td><td></td><td>531</td><td>450</td><td></td><td></td></tr>
<tr><td>7-1-7</td><td></td><td>394</td><td></td><td>1</td><td></td><td></td><td></td></tr>
<tr><td>7-1-7</td><td></td><td>373 or</td><td>3</td><td></td><td rowspan="3">1</td><td></td><td>As Required per Fig. 7-1-6</td></tr>
<tr><td>7-1-7</td><td></td><td>400 or</td><td>5</td><td></td><td></td><td></td></tr>
<tr><td>7-1-7</td><td></td><td>542</td><td>50</td><td></td><td></td><td>For Nonadjacent Units</td></tr>
<tr><td>7-1-7</td><td></td><td>397</td><td></td><td></td><td>A/R</td><td></td><td>See Fig. 7-1-6, Fig. A</td></tr>
<tr><td rowspan="5">Synchronization for Timing Distribution Cable in a Single Shelf Assembly</td><td>7-1-8</td><td>ED8C724-20</td><td>339 or</td><td>100</td><td rowspan="4">2</td><td></td><td></td><td></td></tr>
<tr><td>7-1-8</td><td></td><td>340 or</td><td>300</td><td></td><td></td><td></td></tr>
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OC-3 REAR ACCESS CABLE ORDER BLANK (SHEET 6 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes	
Office Alarm Interface and MULT Cable Required Between Adjacent Units	7-1-9	ED8C724-20	357 or	150	1				
	7-1-9		538	50					
	7-1-9	ED8C724-22	47 or	250	1				
	7-1-9		359 or	3.25		1			
	7-1-9		540	20				For nonadjacent units	
Parallel Telemetry Interface and MULT Cable Required Between Adjacent Units	7-1-10	ED8C724-20	362 or	150	1				
	7-1-10		364			1			
Modem, TBOS Interface and MULT Cable for TBOS and Bay MULT Wiring Between Adjacent Units	7-1-11	ED8C724-20	319 or	150	1			Modem	
	7-1-11		534	50					
	7-1-11		348 or	150	1	A/R		TBOS	For (AT&T) ACORN Applications
	7-1-11		533 or	250					
	7-1-11		396 or	150					For Non-ACORN Applications
	7-1-11		549	300					
	7-1-11		351 or			1		With TBOS	
	7-1-11		535 or	4.17					Nonadjacent Units
	7-1-11		354 or					Without TBOS	
	7-1-11		536	4.17					Nonadjacent Units
	7-1-11		537	20					

OC-3 REAR ACCESS CABLE ORDER BLANK (SHEET 7 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes	
X.25 Interface, Miscellaneous Discretes, Orderwire, and IAO LAN Cables as Required for each OC-3 Unit	7-1-12	ED8C724-20	342 or	150	1	1		X.25	Unterminated
	7-1-12		532 or	300					
	7-1-12	ED8C724-22	15 or	50					Terminated on Male Connector
	7-1-12		16 or	75					
	7-1-12		17 or	100					
	7-1-12		18 or	125					
	7-1-12		70 or	250					
	7-1-12		28	125					Term. on Female Conn.
	7-1-12		64	50					AI Switch
	7-1-12		65	150					
	7-1-12		66	250					
	7-1-12	ED8C724-20	346 or	3	1	1		Orderwire	
	7-1-12	ED8C724-22	31 or	17					R8.0 & R8.1
	7-1-12		32	20					BBG10 OHCTL Reqd
	7-1-12		39 or	150	A/R	A/R		IAO LAN	R13.0 and R15.0
	7-1-12		39A or	30					
	7-1-12		39B or	75					
	7-1-12		40	300					
	7-1-12	ED8C724-20	369 or	150	1	1		Miscellaneous Discrete Points 1-15	
	7-1-12		541	50					
	7-1-12	ED8C724-22	33 or	150	1	1		Miscellaneous Discrete Remote Office Appl. Inputs 16-21	
	7-1-12		71	50					

OC-3 REAR ACCESS CABLE ORDER BLANK (SHEET 8 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
Power for Single OC-3 Unit and Fan Assembly	7-1-13	ED8C724-20	377		1			Fan Power
	7-1-13		371		1			Power Riser
Cable Assembly for Fan Alarm	7-1-14	ED8C724-20	320 or	150	1	1		One Per Fan Assembly
	7-1-14		543 or	50				
	7-1-14		375					
For Remote Applications Only. Apply This Termination When No Cable has Been Ordered for Misc. Discrete (RT) per Fig.7-1-13 or GR375 per Fig. B	7-1-14	ED8C724-20	378		1	1		
Power Input Cable for Bay Arrangement of OC-3 Rear Access Units	7-1-15	ED8C724-22	13		1			Power Riser

DDM-2000 OC-3 Front Access Cabling

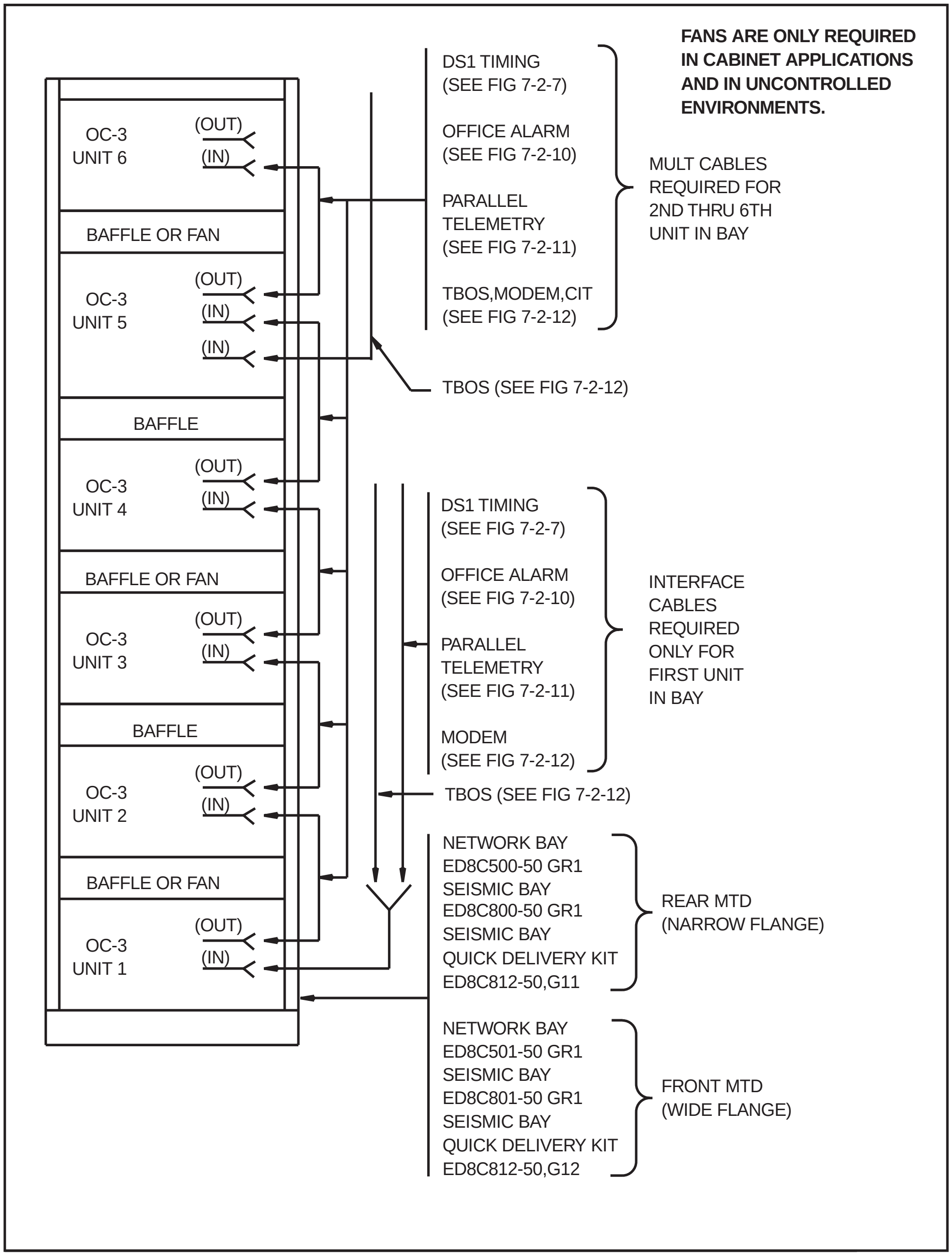


Figure 7-2-1 Typical Bay Arrangement for DDM-2000 OC-3

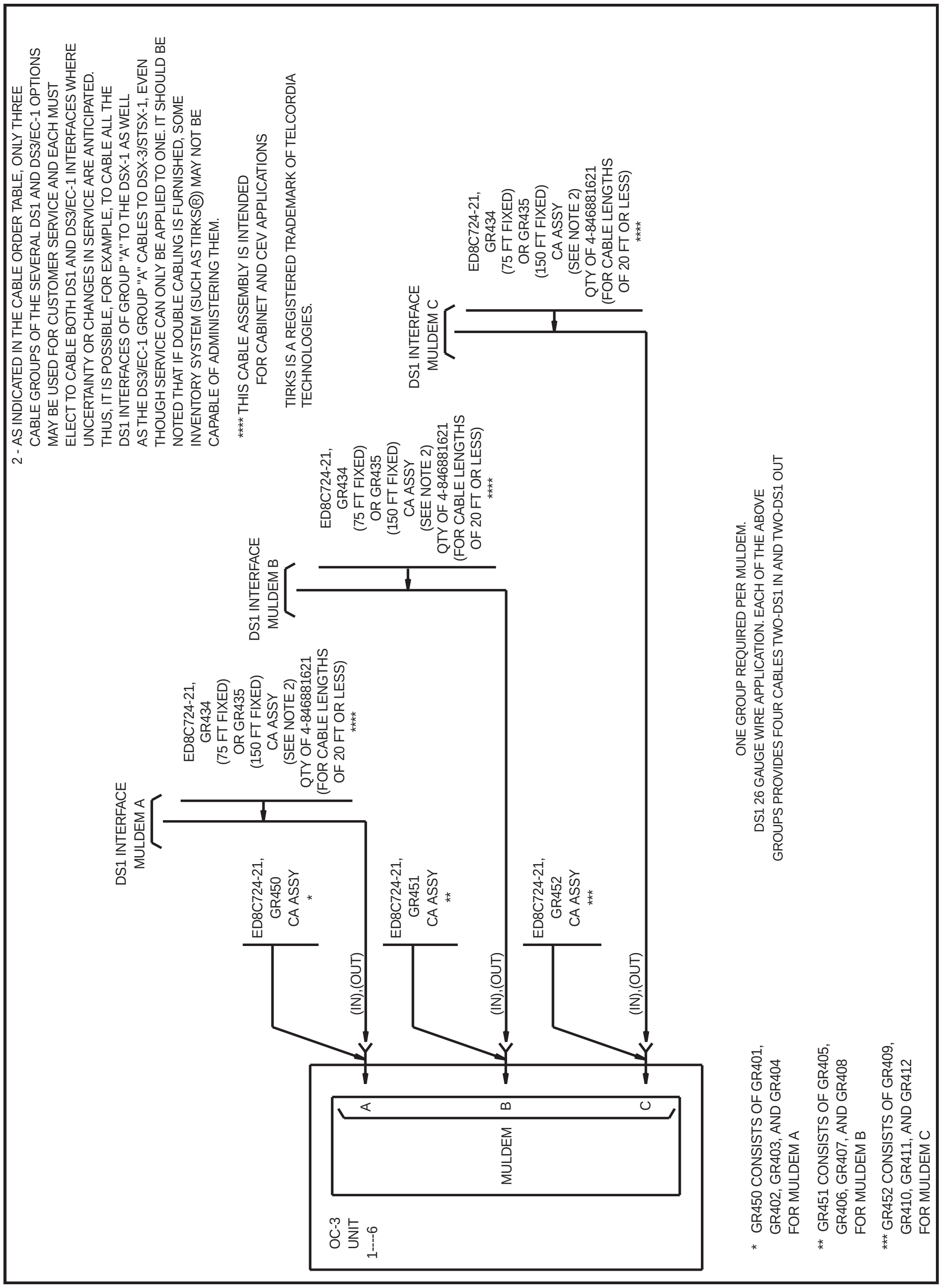


Figure 7-2-2 DS1 Transmission Cables — 26 Gauge

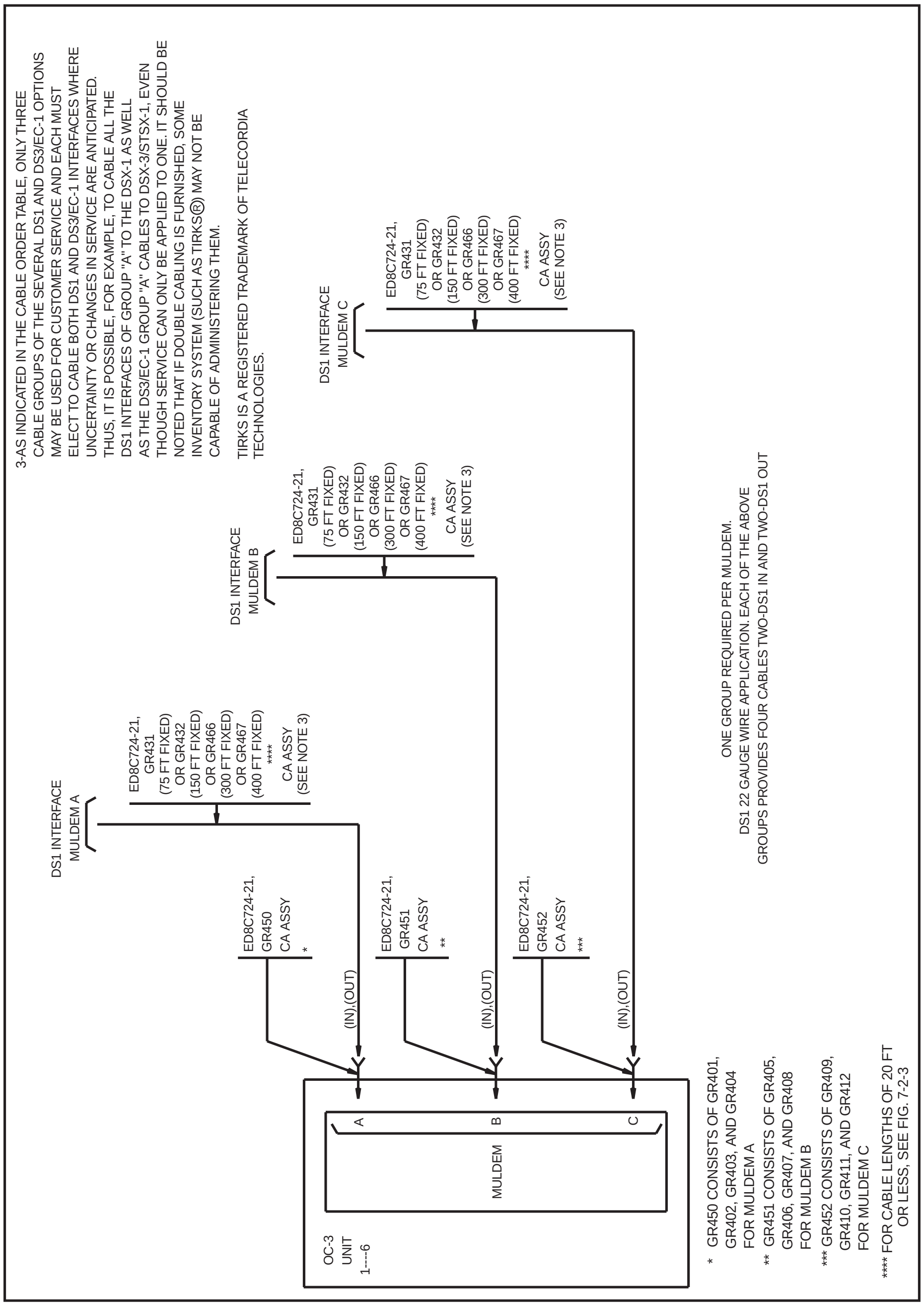


Figure 7-2-3 DS1 Transmission Cables — 22 Gauge

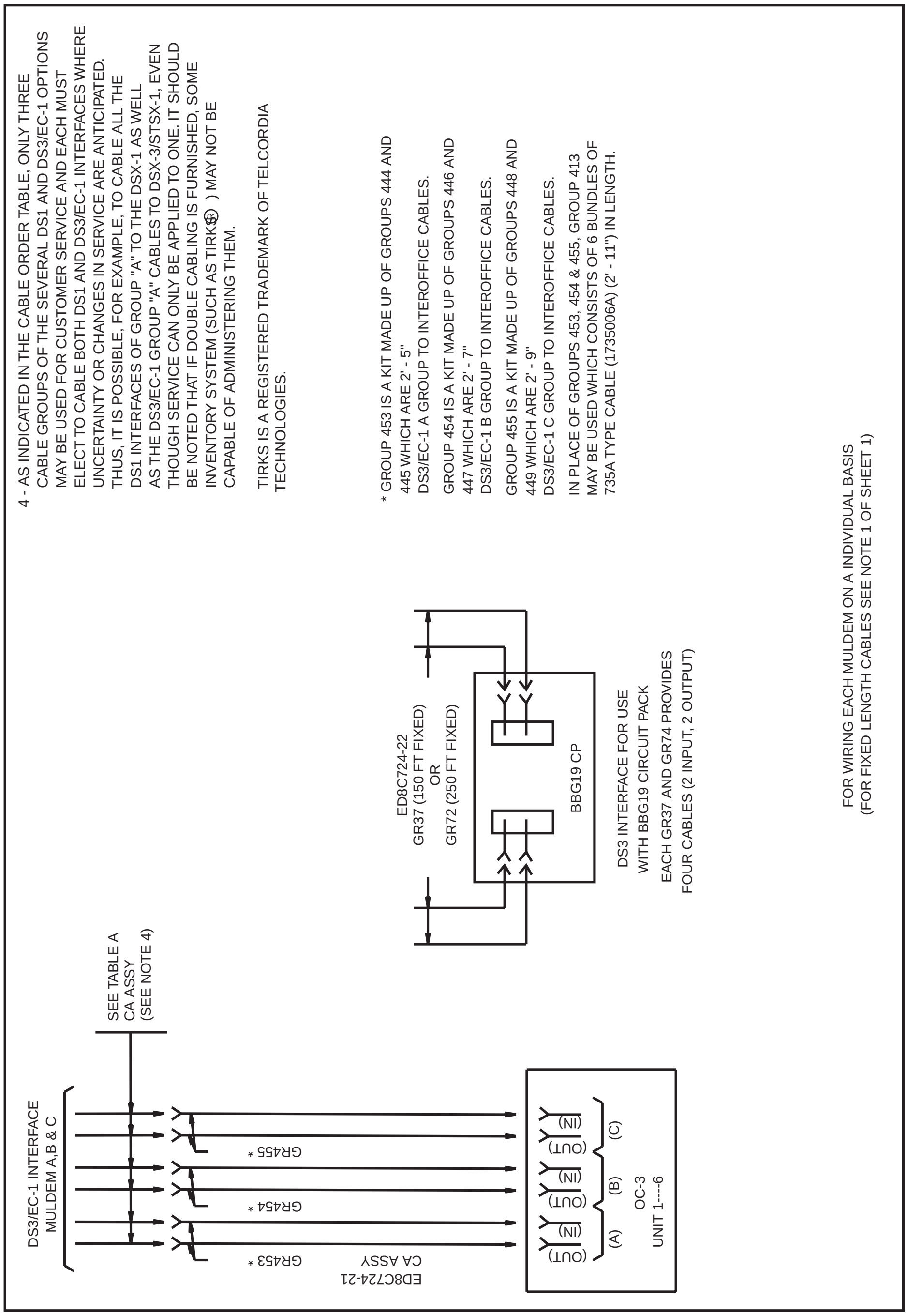


Figure 7-2-5 DS3/EC-1 TRANSMISSION CABLE

Figure 7-2-4 DS3/EC-1 Transmission Cable

TABLE B (OC-3 COAXIAL CABLE APPLICATIONS FOR FRONT ACCESS)

APPLICATION		CABLE TYPE***	ED8C900-12 *	MAXIMUM LENGTH	REMARKS
DSX-3,DSX 3/4, STSX-1		735A (BNC-BNC) †		250 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC) †		250 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC) †		450 FT MAX	MAX SIX CABLES PER SHELF
DACS III-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC) †		500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC) †		500 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC) †		900 FT MAX	MAX SIX CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821AE- BNC) ‡		500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (9821AE-BNC) ‡		500 FT MAX	ONE CABLE PER SHELF **
		734D (9821AE-BNC) ‡		900 FT MAX	MAX SIX CABLES PER SHELF
DACS IV-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC) †		500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC) †		500 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC) †		900 FT MAX	MAX SIX CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821EA-BNC) ‡ (OUT)		500 FT MAX	THREE CABLES MAX PER SHELF
		735A (9821FA-BNC) ‡ (IN)			THREE CABLES MAX PER SHELF
		1735006A (9821EA/F A-BNC) ‡		500 FT MAX	ONE CABLE MAX PER SHELF
		734D (9821EA-BNC) (OUT) ‡		900 FT MAX	THREE CABLES MAX PER SHELF
		734D (9821FA-BNC) (IN) ‡			THREE CABLES MAX PER SHELF

* - ED-8C900-12 HAS REPLA CED ED-8C900-20 FOR ALL DS3/EC-1 ORDERING.
CABLES IN THIS DRAWING ARE SOR TED BY CONNECT OR TYPES.
** - EACH 1735006A CABLE CONTAINS 6 COAXIAL CABLES WITH ASSOCIATED CONNECTORS.
† - STRAIGHT AND RIGHT ANGLE
‡ - RIGHT ANGLE ONL Y

Figure 7-2-5 DS3/EC-1 Transmission Cable

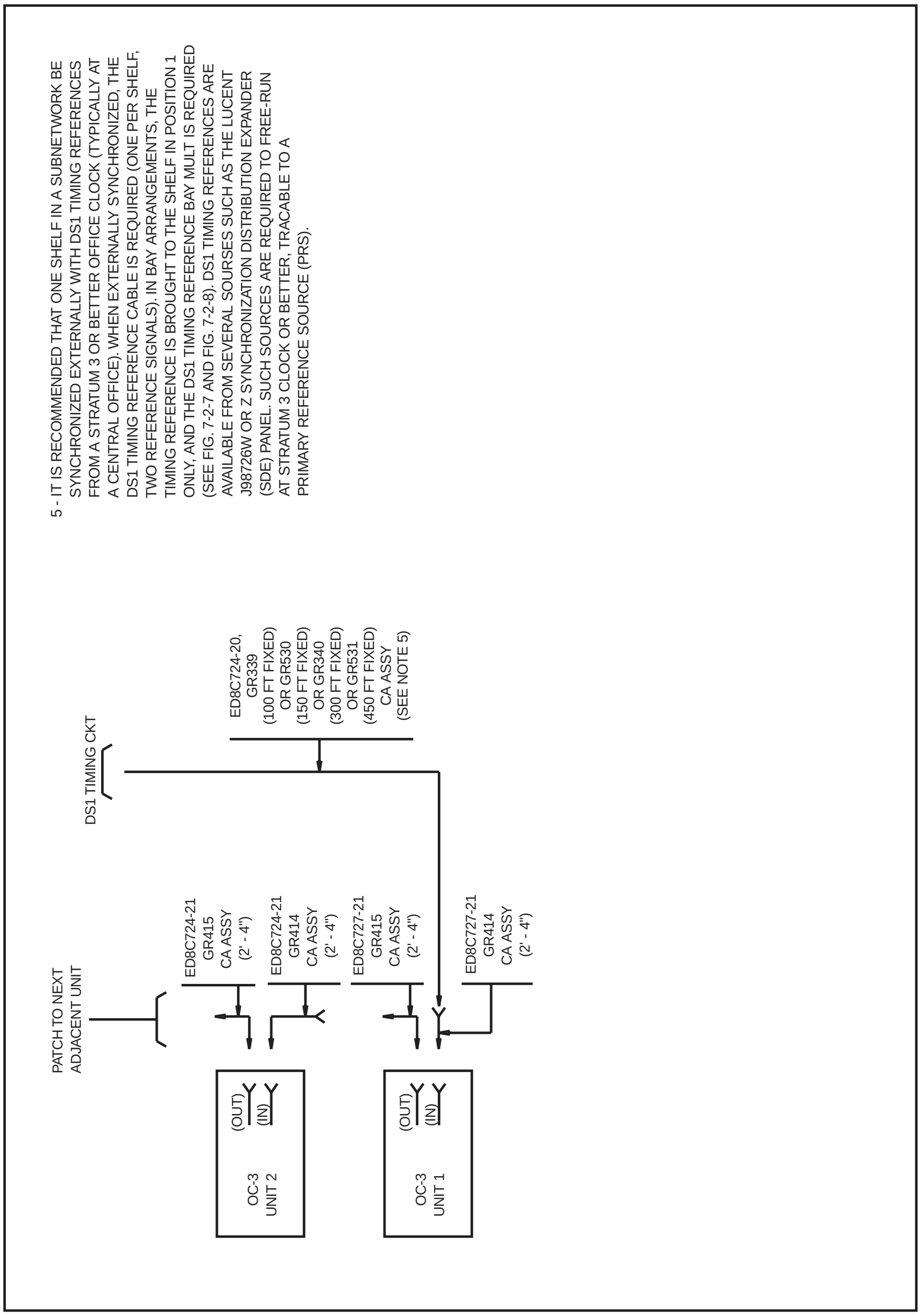


Figure 7-2-6 DS1 Timing Reference Interface and Mult Cable

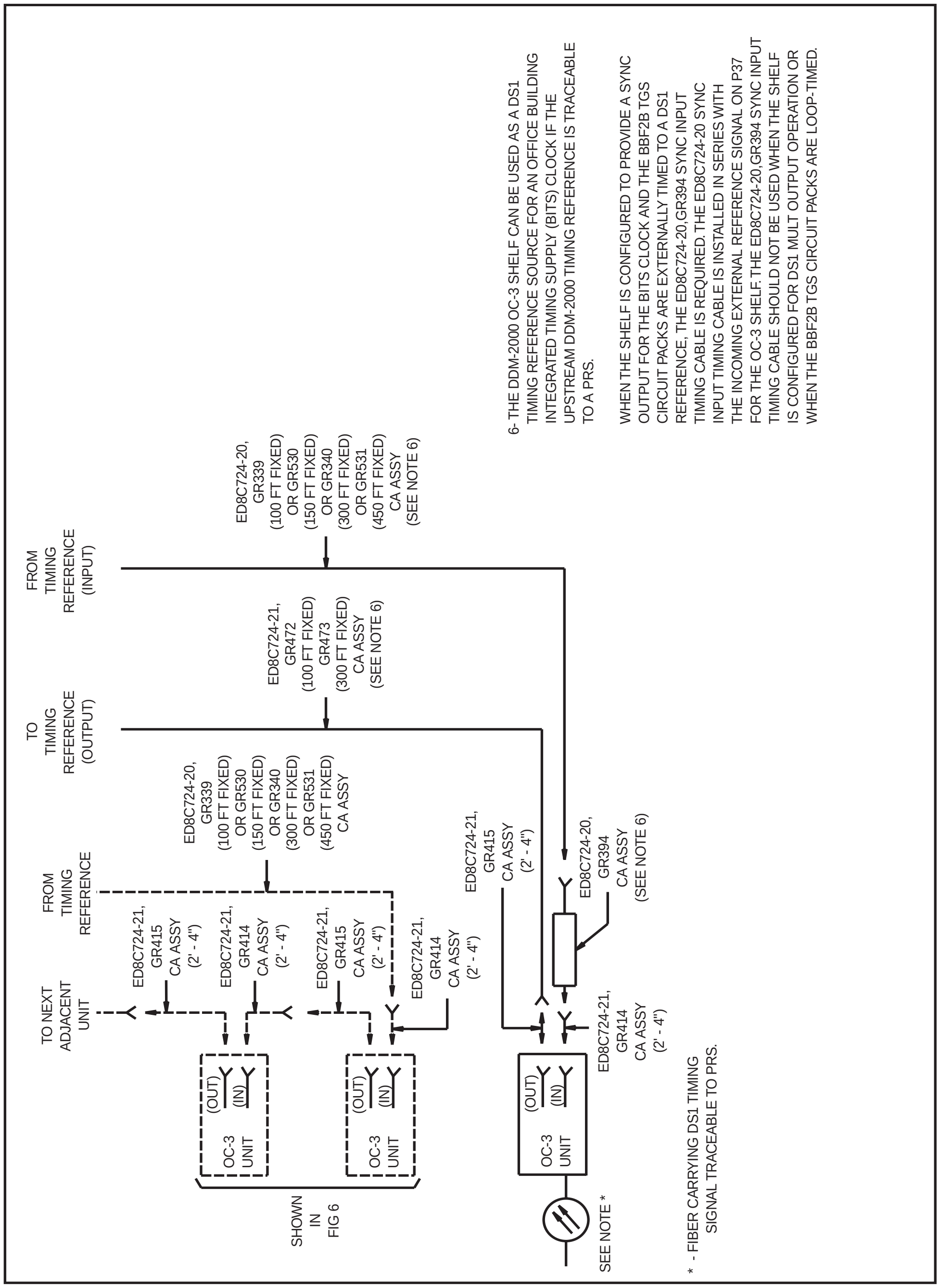


Figure 7-2-7 **Synchronization for Timing Distribution Cable in a Bay Arrangement**

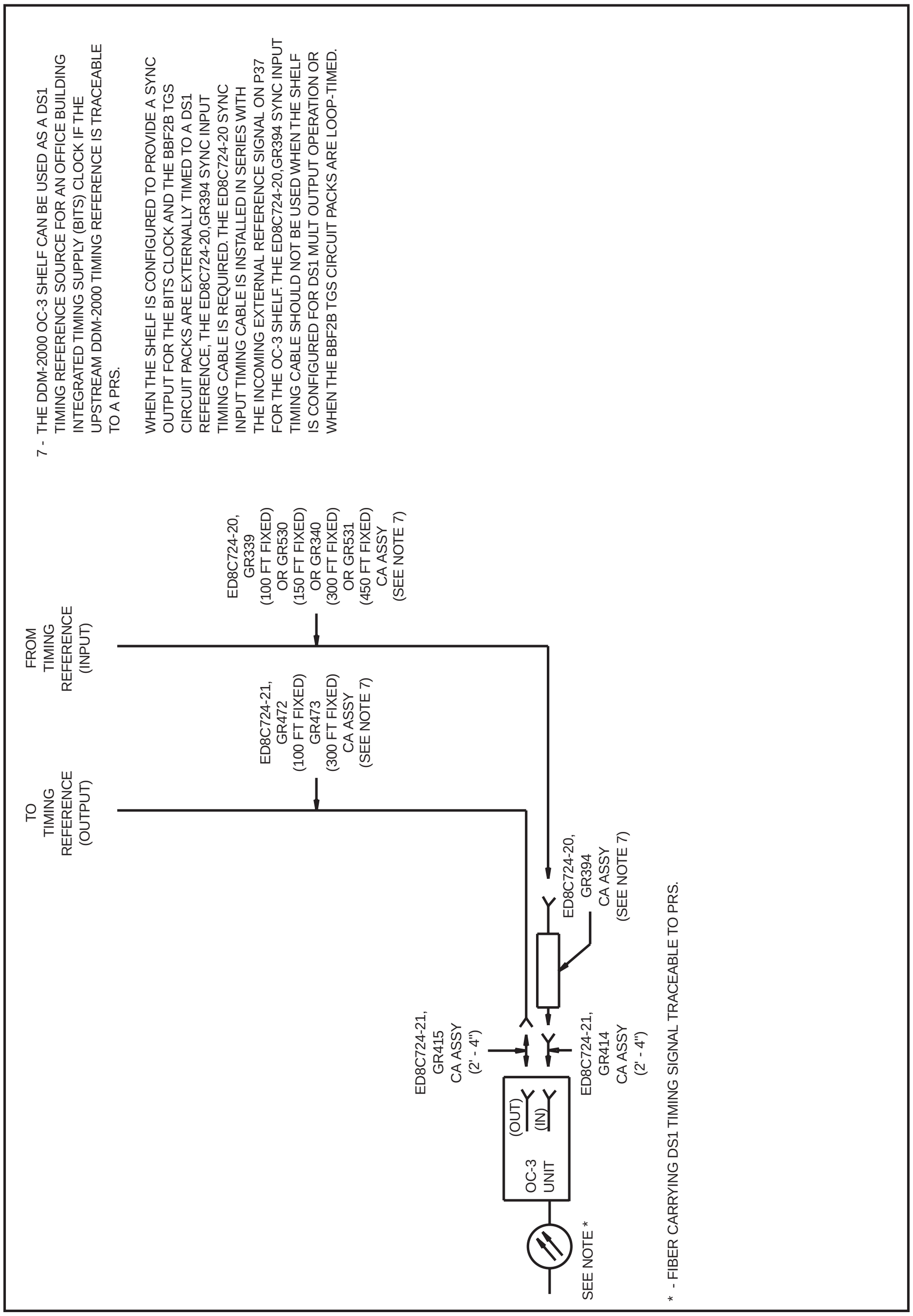


Figure 7-2-8 Synchronization for Timing Distribution Cable in a Single Shelf Assembly

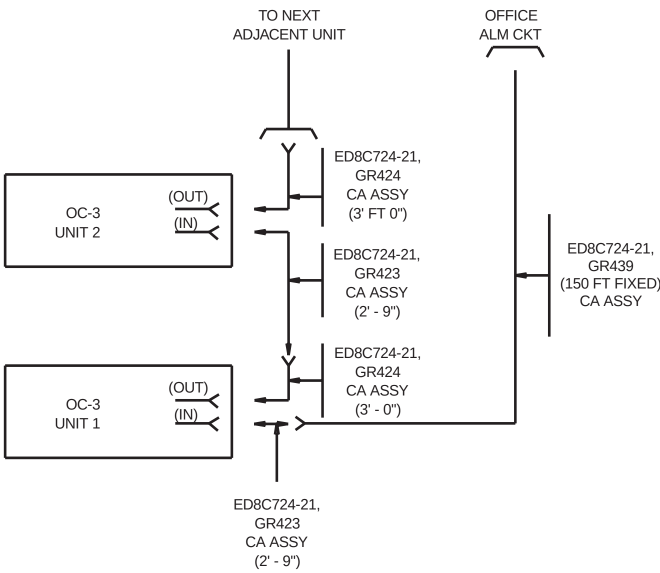


Figure 7-2-9 Office Alarm Interface and Mult Cable

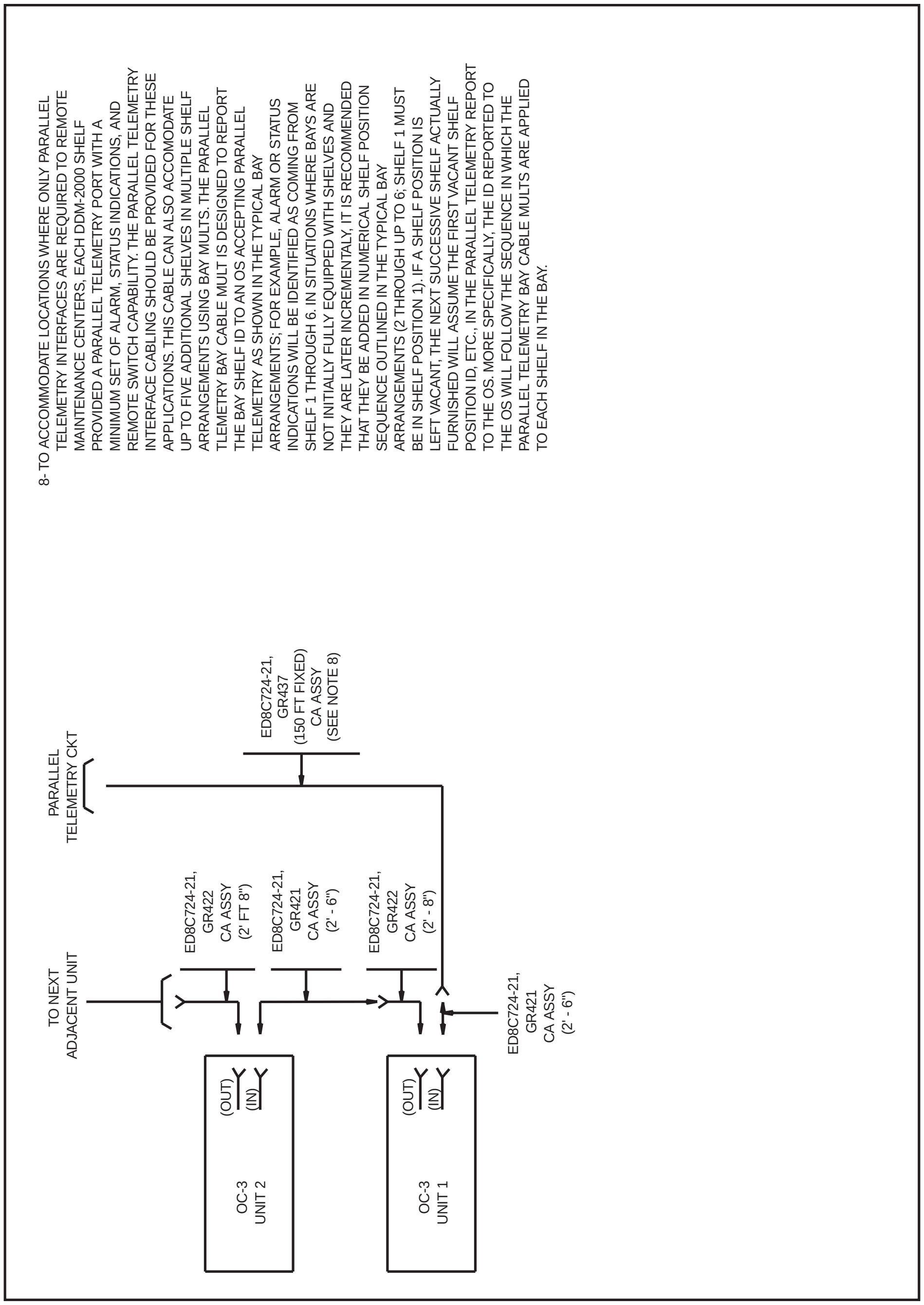


Figure 7-2-10 Parallel Telemetry Interface and Mult Cable

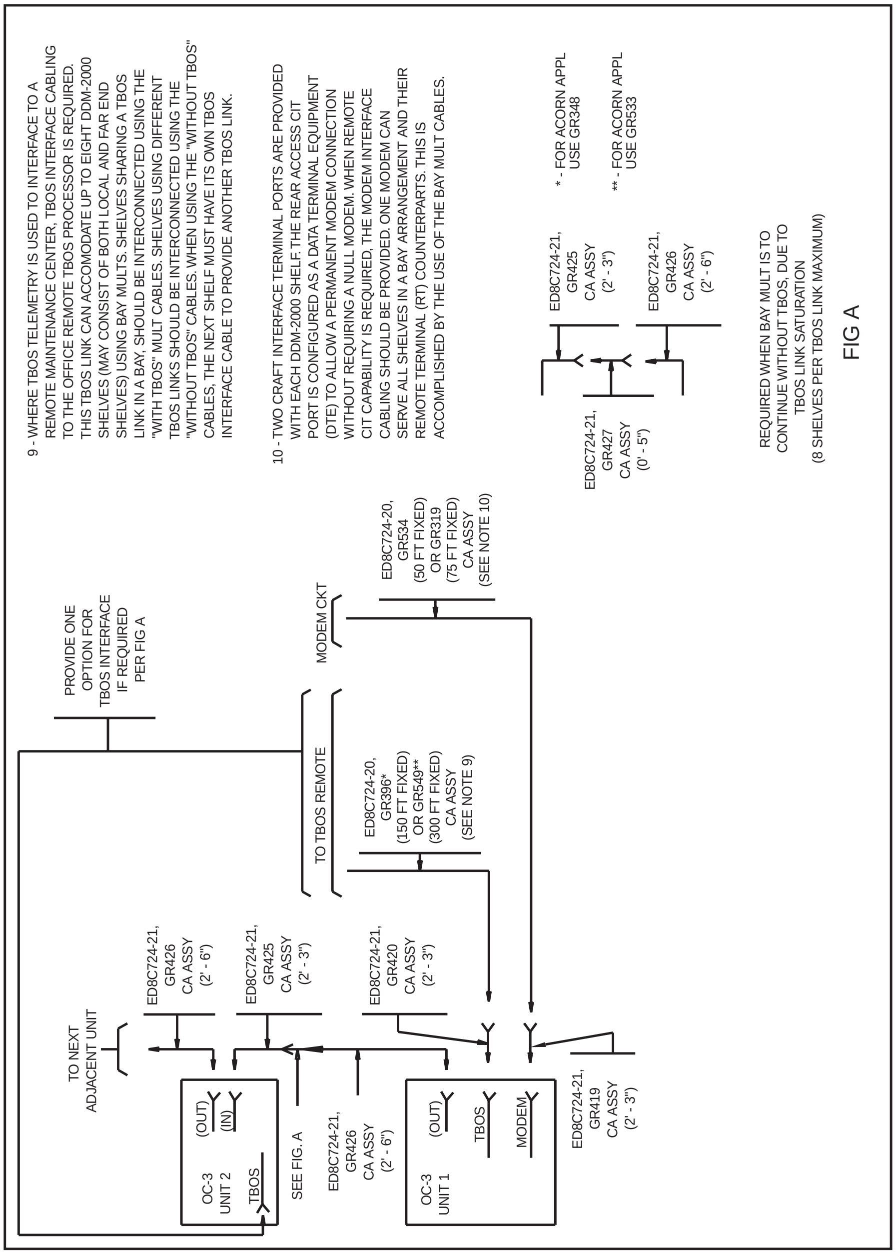


Figure 7-2-11 Modem, TBOS Interface and Bay Mult Cable for TBOS, CIT, and Modem

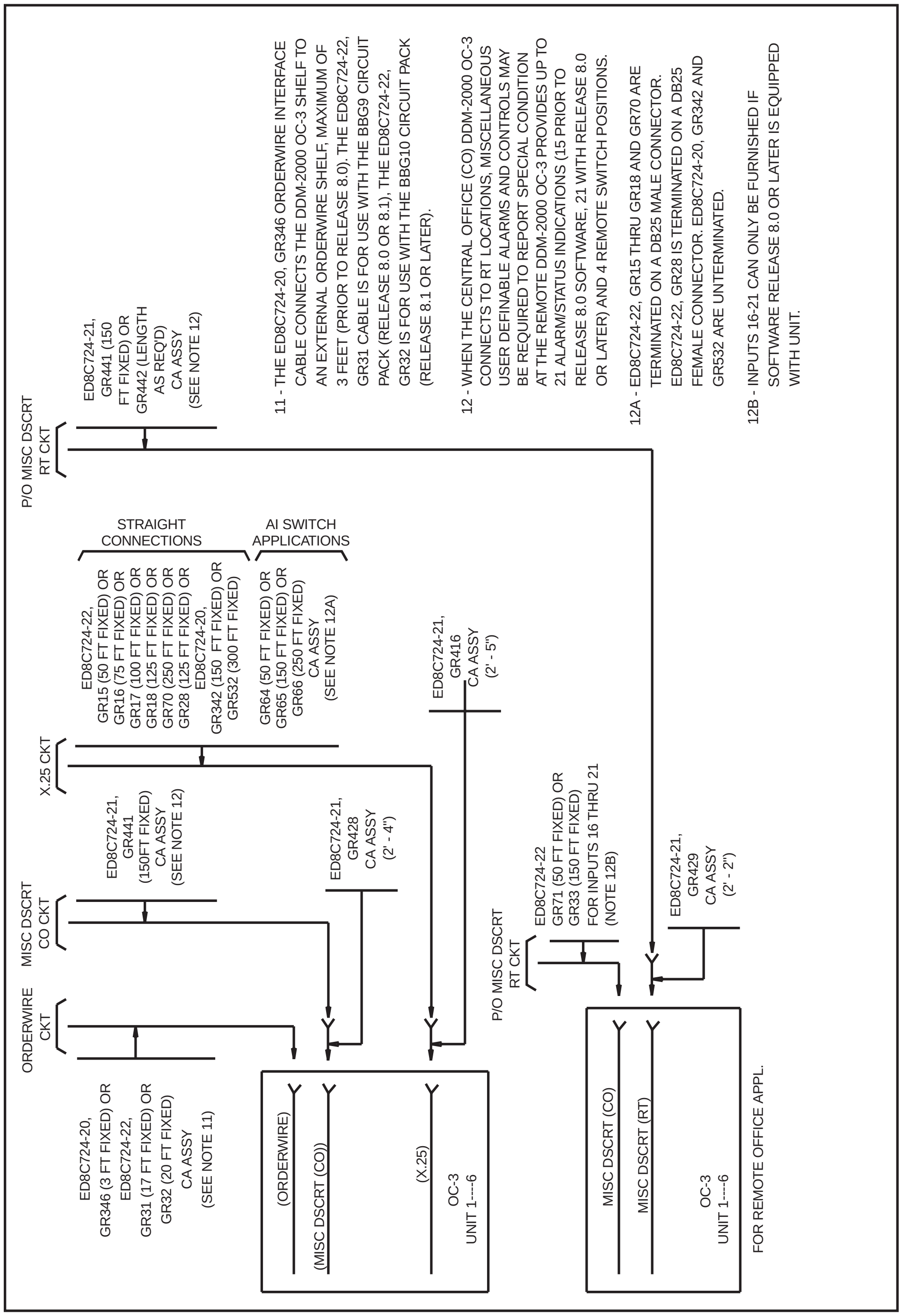


Figure 7-2-12 X.25 Interface, Miscellaneous Discretes, and Orderwire

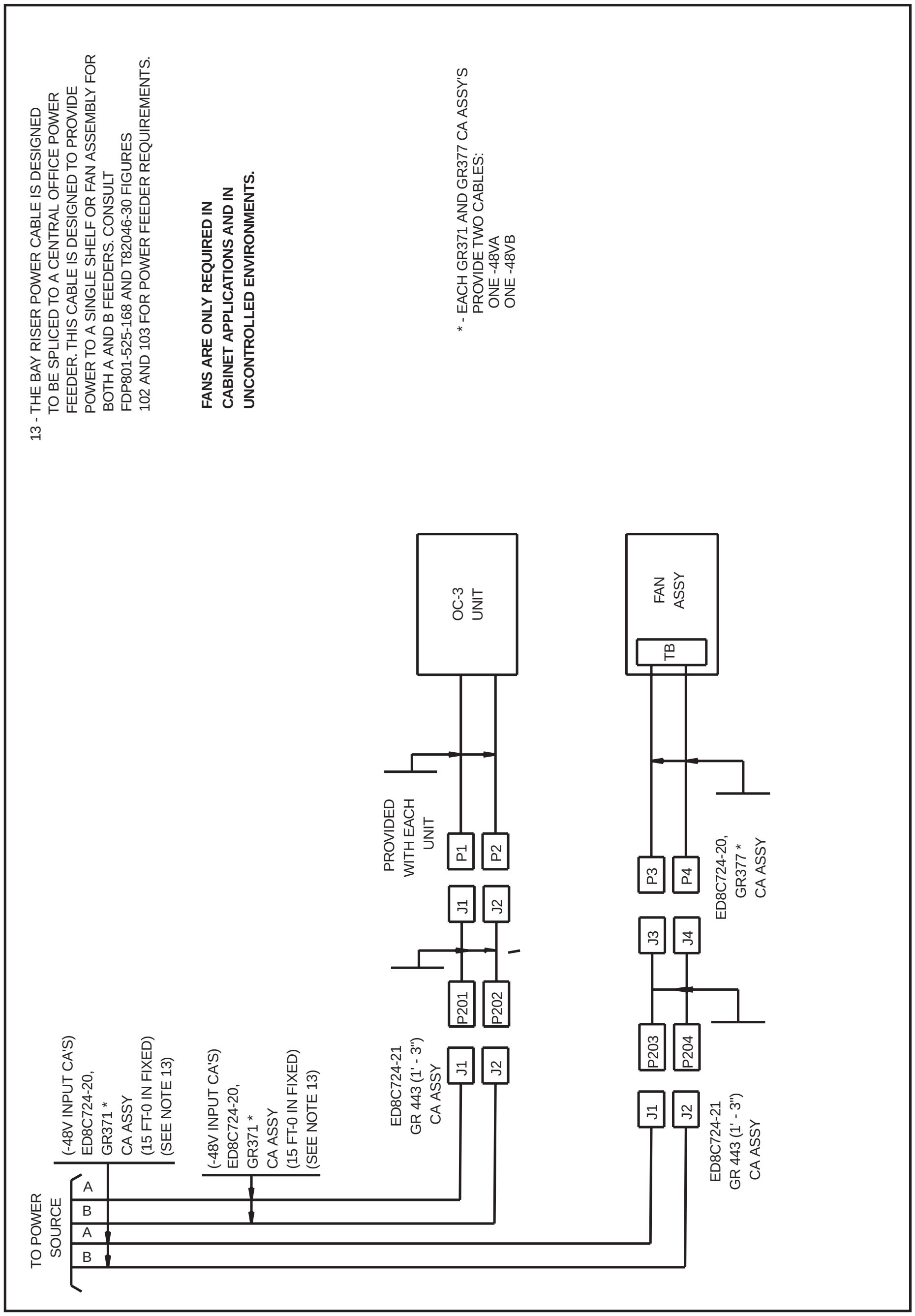


Figure 7-2-13 Power for Single OC-3 Unit and Fan Assembly

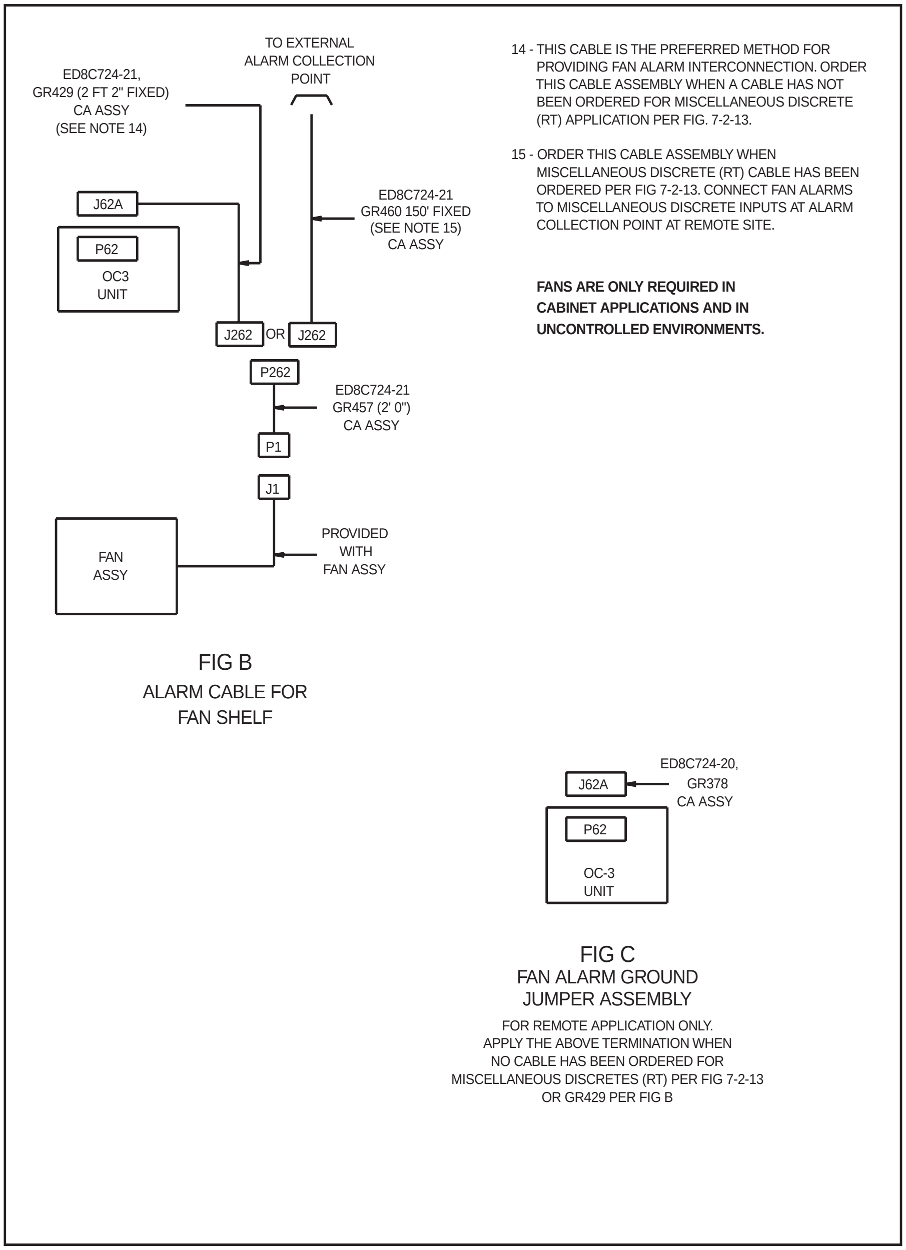


Figure 7-2-14 Alarm Cable for Fan Shelf and Fan Alarm Ground Jumper Assembly

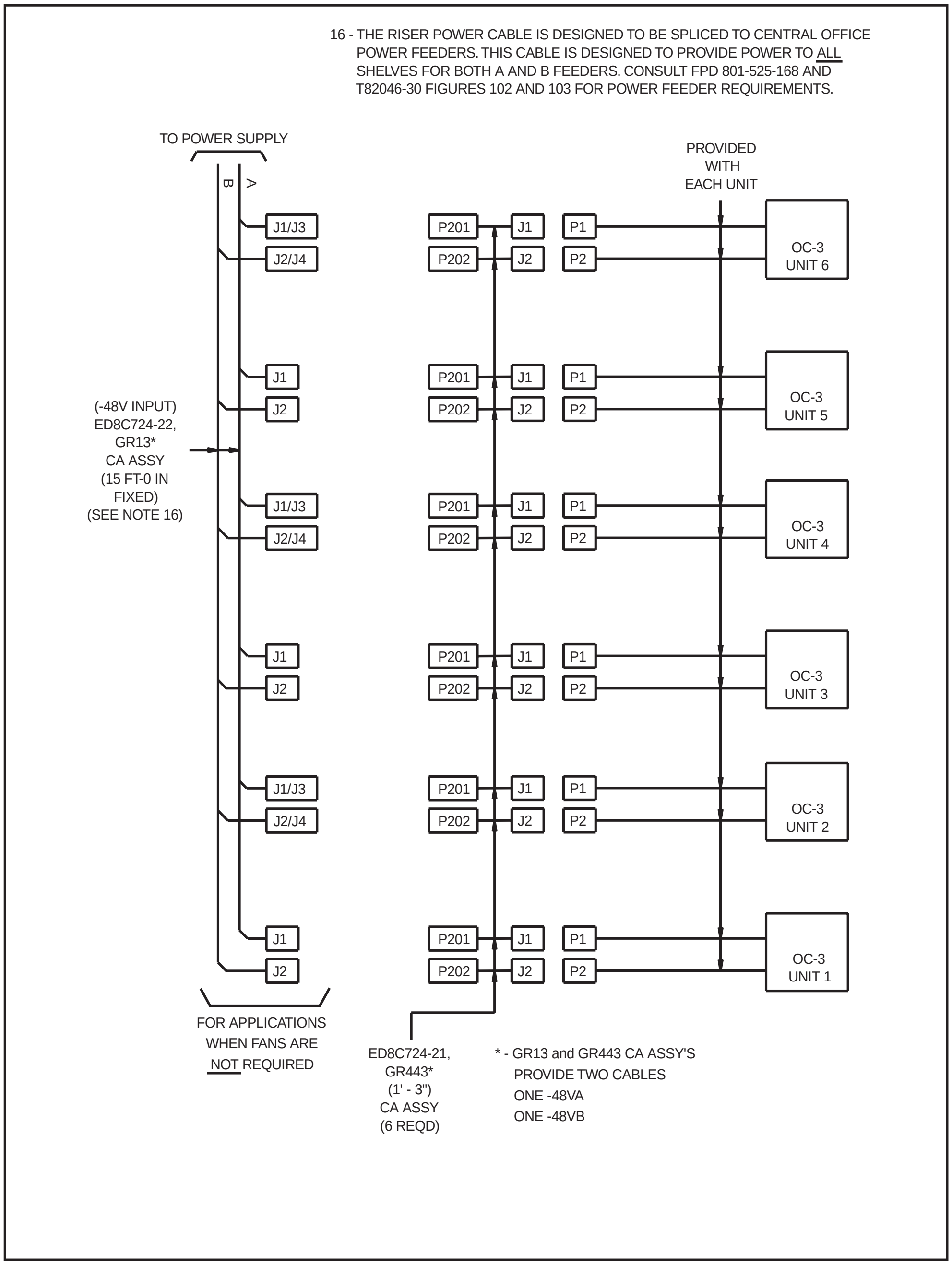


Figure 7-2-15 Power Input Cable for Bay Arrangement of OC-3 Front Access Units Without Fan Assembly

OC-3 FRONT ACCESS CABLE ORDER BLANK (SHEET 1 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
DS1 26-Gauge Wire Application, One Group Required per MULDEM	7-2-2	ED8C724-21	434 or	75	3	3		One Group per MULDEM
	7-2-2		435	150				
	7-2-2	846881621			12	12		Four per MULDEM
	7-2-2	ED8C724-21	450		1	1		MULDEM A
	7-2-2		451		1	1		MULDEM B
	7-2-2		452		1	1		MULDEM C
DS1 22-Gauge Wire Application, One Group Required per MULDEM	7-2-3	ED8C724-21	431 or	75	3	3		One Group per MULDEM
	7-2-3		432 or	150				
	7-2-3		466	300				
	7-2-3		467	400				
	7-2-3		450		1	1		MULDEM A
	7-2-3		451		1	1		MULDEM B
	7-2-3		452		1	1		MULDEM C

OC-3 FRONT ACCESS CABLE ORDER BLANK (SHEET 2 OF 8)

Fig. Description	Fig.	Code	Group/ Comcode Num	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
735A Cable for DS3/EC-1 Applications When Wiring Each MULDEM on an Individual Basis	7-2-4/ 7-2-5	ED-8C900-12	108799511* (Table 1U)	150	6	6		Note 1
	7-2-4/ 7-2-5	ED8C724-21	453		1	1		MULDEM A
	7-2-4/ 7-2-5		454		1	1		MULDEM B
	7-2-4/ 7-2-5		455		1	1		MULDEM C
	7-2-4/ 7-2-5		413		See Note	See Note		One Group 413 may be Used in Place of Groups 453 to 455
735A Cable for DS3 Interface with BBG19	7-2-4/ 7-2-5	ED8C724-22	37 or	150	1	1		One Group Required per MULDEM
	7-2-4/ 7-2-5		74	250				

* Straight BNC — loose straight BNC.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

OC-3 FRONT ACCESS CABLE ORDER BLANK (SHEET 3 OF 8)

Fig. Description	Fig.	Code	Group/ Comcode Num	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
1735006A Cable for DS3/EC-1 Applications When all Three MULDEMs are Wired at the Same Time	7-2-5	ED-8C900-12	108811548* (Table 4U)	150	1	1		Note 1
	7-2-5	ED8C724-21	453		1	1		MULDEM A
	7-2-5		454		1	1		MULDEM B
	7-2-5		455		1	1		MULDEM C
	7-2-5		413		See Note	See Note		One Group 413 may be Used in Place of Groups 453 to 455

* Straight BNC — loose straight BNC.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

OC-3 FRONT ACCESS CABLE ORDER BLANK (SHEET 4 OF 8)

Fig. Description	Fig.	Code	Group/ Comcode Num	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
734D Cable for DS3/EC-1 Applications When Cable Length Exceeds the 735 Type Cable Requirements	7-2-5	ED8C900-12	108817800* (Table 6G)	300	6	6		Notes 1 and 2
	7-2-5	ED8C724-21	453		1	1		MULDEM A
	7-2-5		454		1	1		MULDEM B
	7-2-5		455		1	1		MULDEM C
	7-2-5		413					One Group 413 may be Used in Place of Groups 453 to 455

* Straight BNC — no connector.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

Note 2: One end has no connector. Order with comcode 407772235 for straight BNC. See Table 7A from ED-8C900-12 for other connector types.

OC-3 FRONT ACCESS CABLE ORDER BLANK (SHEET 5 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
DS1 Timing Input and MULT Cable Required Between Adjacent Units	7-2-6	ED8C724-20	339 or	100	1			
	7-2-6		340 or	300				
	7-2-6		530 or	150				
	7-2-6		531	450				
	7-2-6	ED8C724-21	414		1	1		
	7-2-6		415		1	1		
Synchronization for Timing Distribution Cable in a Bay Arrangement	7-2-7	ED8C724-20	339 or	100	1	1		
	7-2-7		340 or	300				
	7-2-7		530 or	150				
	7-2-7		531	450				
	7-2-7		394		1			
	7-2-7	ED8C724-21	414		1	See Note		As Required per Fig. 7-2-7
	7-2-7		415		1	See Note		As Required per Fig. 7-2-7
	7-2-7		472	100	1			
	7-2-7		473	300	1			
Synchronization for Timing Distribution Cable in a Single Shelf Assembly	7-2-8	ED8C724-20	339 or	100	1			
	7-2-8		340 or	300				
	7-2-8		530 or	150				
	7-2-8		531	450				
	7-2-8		394		1			
	7-2-8	ED8C724-21	414		1			
	7-2-8		415		1			
	7-2-8		458		1			
	7-2-8		472	100	1			
	7-2-8		473	300	1			
Office Alarm Interface and MULT Cable Required Between Adjacent Units	7-2-9	ED8C724-21	439 or	150	1			
	7-2-9		423		1	1		
	7-2-9		424		1	1		

OC-3 FRONT ACCESS CABLE ORDER BLANK (SHEET 6 OF 8)

<table>
<tr><th>Fig. Description</th><th>Fig.</th><th>Code</th><th>Group Num</th><th>Enter Length (Feet) if Reqd</th><th>Qty Reqd for First Unit in Bay</th><th>Qty Reqd for Each Addnl Unit in Bay</th><th>Qty to be Ordered</th><th colspan="2">Notes</th></tr>
<tr><td rowspan="4">Parallel Telemetry Interface and MULT Cable Required Between Adjacent Units</td><td>7-2-10</td><td>ED8C724-21</td><td>437 or</td><td>150</td><td rowspan="2">1</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>7-2-10</td><td></td><td>438</td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>7-2-10</td><td></td><td>421</td><td></td><td>1</td><td>1</td><td rowspan="2"></td><td colspan="2"></td></tr>
<tr><td>7-2-10</td><td></td><td>422</td><td></td><td>1</td><td>1</td><td colspan="2"></td></tr>
<tr><td rowspan="12">Modem, TBOS Interface and MULT Cable for TBOS and Bay MULT Wiring Between Two Adjacent Units</td><td>7-2-11</td><td>ED8C724-20</td><td>319 or</td><td>75</td><td rowspan="2">1</td><td></td><td rowspan="2"></td><td colspan="2" rowspan="2">Modem</td></tr>
<tr><td>7-2-11</td><td></td><td>534</td><td>50</td><td></td></tr>
<tr><td>7-2-11</td><td></td><td>348 or</td><td>150</td><td rowspan="4">1</td><td rowspan="4">A/R</td><td rowspan="4"></td><td rowspan="4">TBOS</td><td rowspan="2">For (AT&T) ACORN Applications</td></tr>
<tr><td>7-2-11</td><td></td><td>533 or</td><td>250</td></tr>
<tr><td>7-2-11</td><td></td><td>396 or</td><td>150</td><td rowspan="2">For Non-ACORN Applications</td></tr>
<tr><td>7-2-11</td><td></td><td>549</td><td>300</td></tr>
<tr><td>7-2-11</td><td></td><td>352</td><td></td><td>See Note</td><td>A/R</td><td></td><td colspan="2">See Fig. 7-2-11 to Determine if Needed</td></tr>
<tr><td>7-2-11</td><td>ED8C724-21</td><td>427</td><td></td><td>1</td><td>1</td><td rowspan="2"></td><td colspan="2">Only Required per Fig. A</td></tr>
<tr><td>7-2-11</td><td></td><td>419</td><td></td><td>1</td><td></td><td colspan="2">MODEM</td></tr>
<tr><td>7-2-11</td><td></td><td>420</td><td></td><td>1</td><td>A/R</td><td rowspan="3"></td><td colspan="2" rowspan="3">TBOS</td></tr>
<tr><td>7-2-11</td><td></td><td>425</td><td></td><td></td><td>1</td></tr>
<tr><td>7-2-11</td><td></td><td>426</td><td></td><td>1</td><td>1</td></tr>
</table>

OC-3 FRONT ACCESS CABLE ORDER BLANK (SHEET 7 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes	
X.25 Interface, Miscellaneous Discretes, and Orderwire Cables as Required for Each OC-3 Unit	7-2-12	ED8C724-20	342 or	150	1	1		X.25	Unterminated
	7-2-12		532 or	300					
	7-2-12	ED8C724-22	15 or	50					Terminated on Male Connector
	7-2-12		16 or	75					
	7-2-12		17 or	100					
	7-2-12		18 or	125					
	7-2-12		70 or	250					
	7-2-12		28	125					Term. on Female Conn.
	7-2-12	ED8C724-21	416		1	1			
	7-2-12	ED8C724-20	346 or	3	1	1		Orderwire	
	7-2-12	ED8C724-22	31 or	17					R8.0 & R8.1
	7-2-12		32	20					BBG10 OHCTL Reqd
	7-2-12	ED8C724-21	441	150	1	1		Miscellaneous Discrete for Points 1-15	
	7-2-12		428 or		1	1			
	7-2-12		429						
	7-2-12	ED8C724-22	33 or	150	1	1		Miscellaneous Discrete (RT only) for Inputs 16-21	
	7-2-12		71	50					
	7-2-12		64	50				AI Switch	
	7-2-12		65	150					
	7-2-12		66	250					
Power for Single OC-3 Unit and Fan Assembly	7-2-13	ED8C724-21	443		2			Power Cable	
	7-2-13	ED8C724-20	377		1			Fan Power	
	7-2-13		371		2			Power Riser	

OC-3 FRONT ACCESS CABLE ORDER BLANK (SHEET 8 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
Cable Assembly for Fan Alarm	7-2-14	ED8C724-21	457		1	1		One per Fan Assembly
	7-2-14		429 or		1	1		One per Fan Assembly
	7-2-14		460	150				
For Remote Applications Only. Apply This Termination When No Cable has Been Ordered for Misc. Discretes (RT) per Fig.7-2-13 or GR429 per Fig. B	7-2-14	ED8C724-20	378		1	1		
Power Input Cable for Bay Arrangement of OC-3 Front Access Units	7-2-15	ED8C724-22	13		1			Power Riser
	7-2-15	ED8C724-21	443		1	1		One per Each Shelf Assembly — Power Cable

Typical Bay Arrangement for Combined OC-3/OC-12 Bays

Figure 7-3-1 for rear access and Figure 7-4-1 for front access provide a typical bay arrangement for future upgrading from four DDM-2000 independent OC-3 shelves to an OC-12 shelf. In this arrangement, space is reserved at the bottom of the bay for later addition of the OC-12 shelf. The four DDM-2000 OC-3 shelves may be equipped initially for point-to-point OC-3 transport, as those described in the previous sections.

The bay mult cabling engineering for an OC-12 upgrade bay will depend upon how the cabling was originally engineered for the OC-3 arrangement. Various combinations of the cable groups ED-8C724-20, G380 through G393 must be selected to upgrade to the DDM-2000 OC-12 multiplexer.

For ordering the DDM-2000 OC-12 shelf and plug-ins, use Section 8, "OC-12 Ordering."

Lightguide Jumper and Lightguide Slack Storage Shelf

Interworking of DDM-2000 OC-3 and OC-12 in the standard combined bay arrangement (ED-8C724-10) requires multimode lightguide jumpers and a lightguide slack storage shelf.

Order the shelf as follows:

LSJ1LP-10/2.5 Lightguide Slack Storage Shelf, 106795057

Order the required multimode lightguide jumpers (*ST*®-*ST*) as follows:

Qty, FL1E-E, 106471345
Equipped With Qty (x) Length (feet), 1860A Cable, 10376460,
Qty cables x feet long each

Normally four jumpers are required per shelf: two transmit and receive for both service and protection.

Lengths required between the OC-12 shelf and the OC-3 shelves in the standard combined bay arrangement are as follows:

- OC-3 shelf position 1 - 8 feet
- OC-3 shelf position 2 - 9 feet
- OC-3 shelf position 3 - 10 feet
- OC-3 shelf position 4 - 11 feet.

Jumpers used for nonstandard arrangements can be ordered using the same format. For example, for four multimode jumpers (*ST*-*ST*) each 8 feet, order:

4 FL1E-E, 106471345
Equipped With 32 ft, 1860A Cable, 10376460,
4 cables 8 feet long each

NOTE:
When ordering multiples of the same length, the quantity of assemblies must be multiplied by the length of the assembly. For example, 4 units × 8ft/unit = 32 ft. Failing to do this would result in receiving four assemblies 2 feet long. The only alternative would be to order four separate items.

See the "Miscellaneous Equipment and Tools" section for more information on single-mode and multimode jumpers.

DDM-2000 OC-3/OC-12 Rear Access Cabling Combined

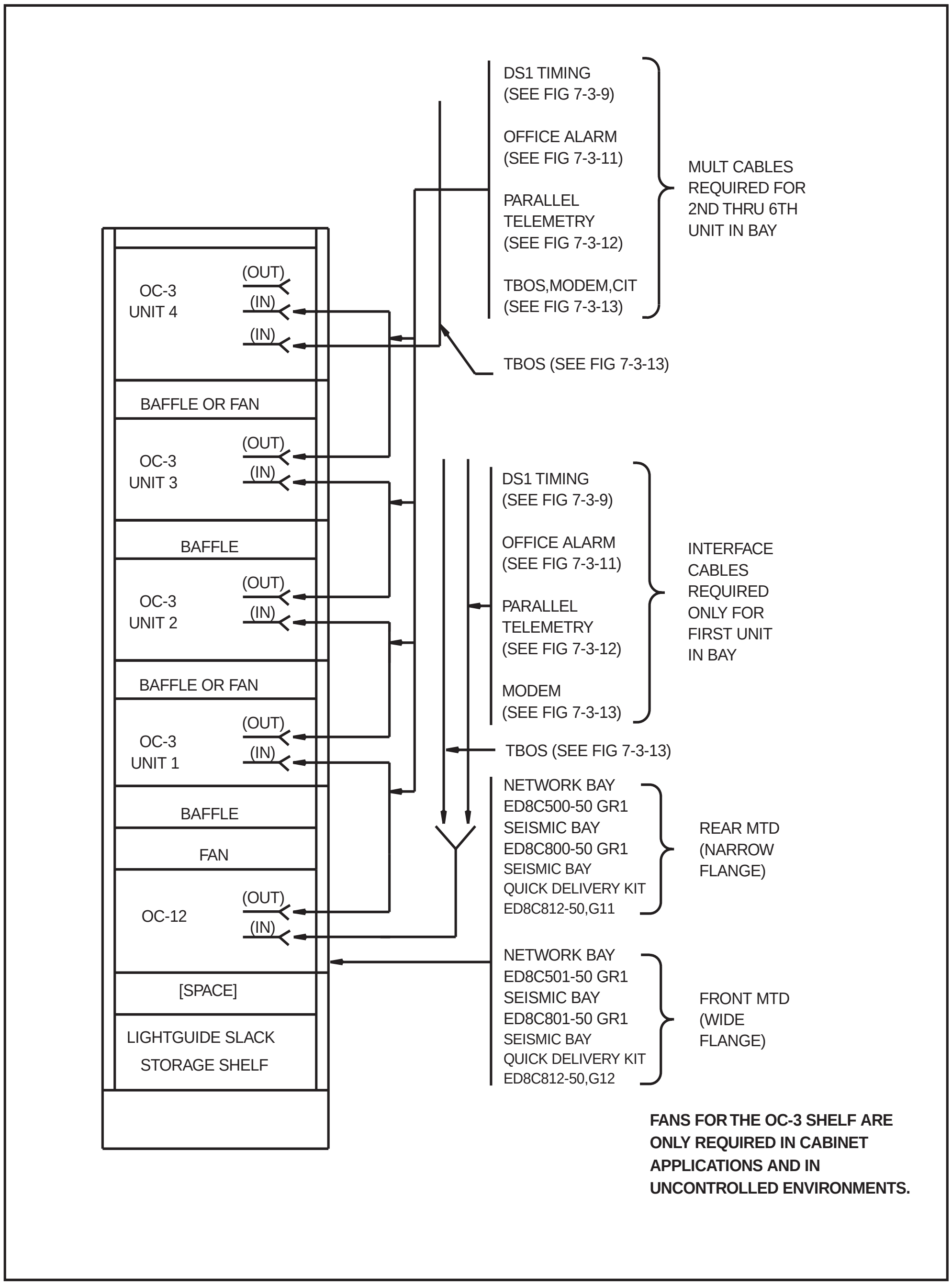


Figure 7-3-1 Typical Bay Arrangement for DDM-2000 OC-3/OC-12 Rear Access

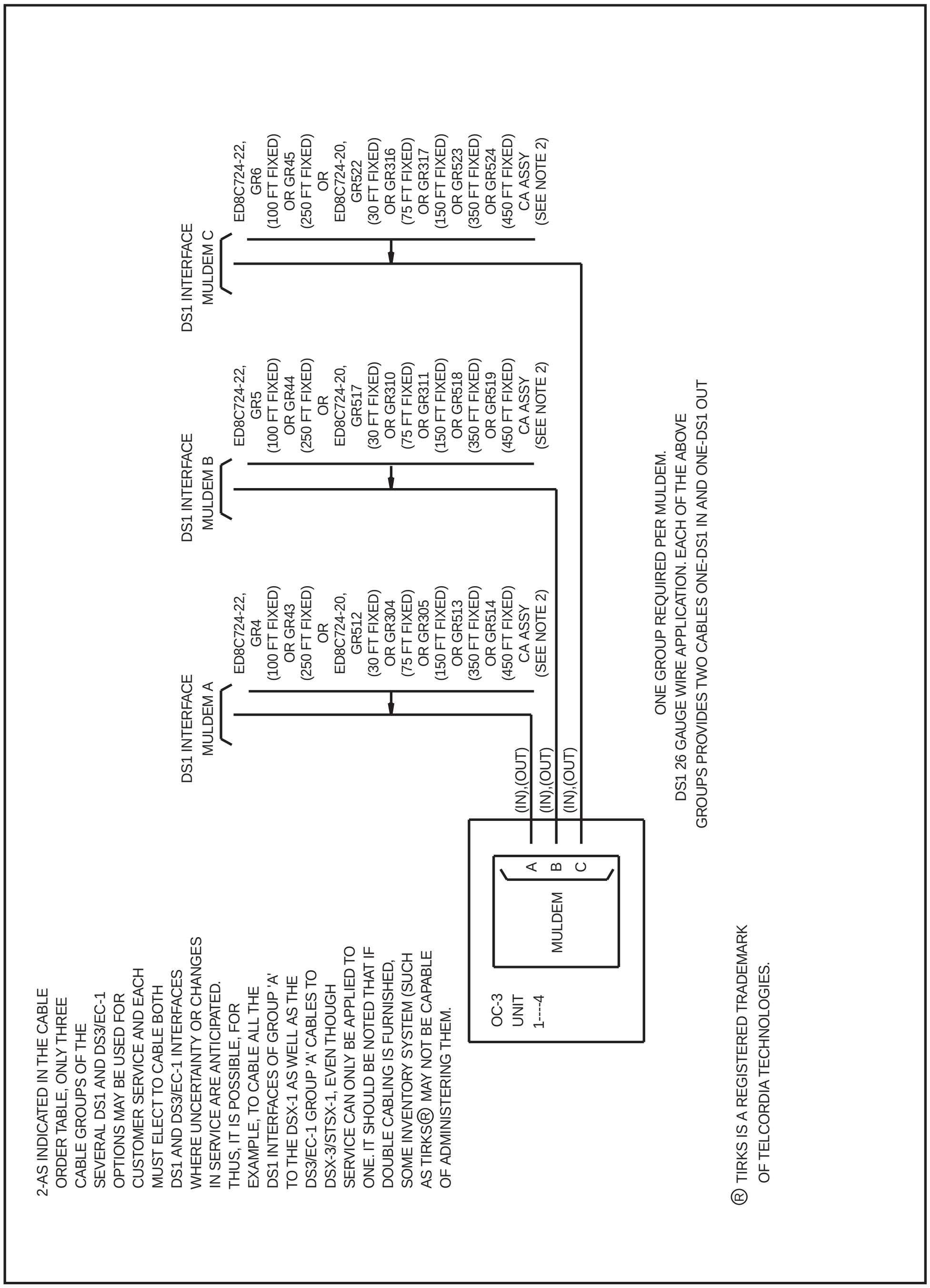


Figure 7-3-2 DS1 Transmission Cables — 26 Gauge

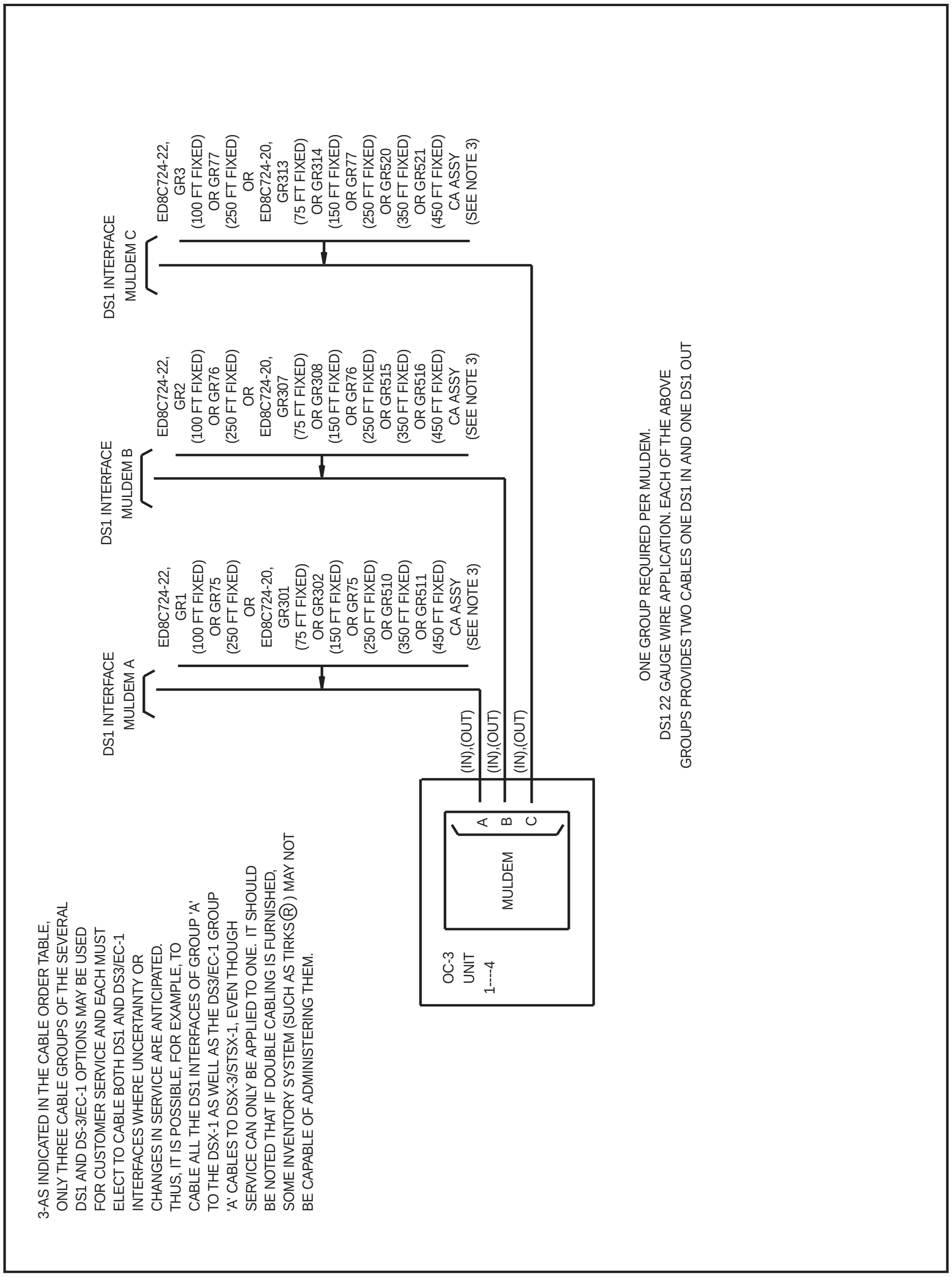


Figure 7-3-3 DS1 Transmission Cables — 22 Gauge

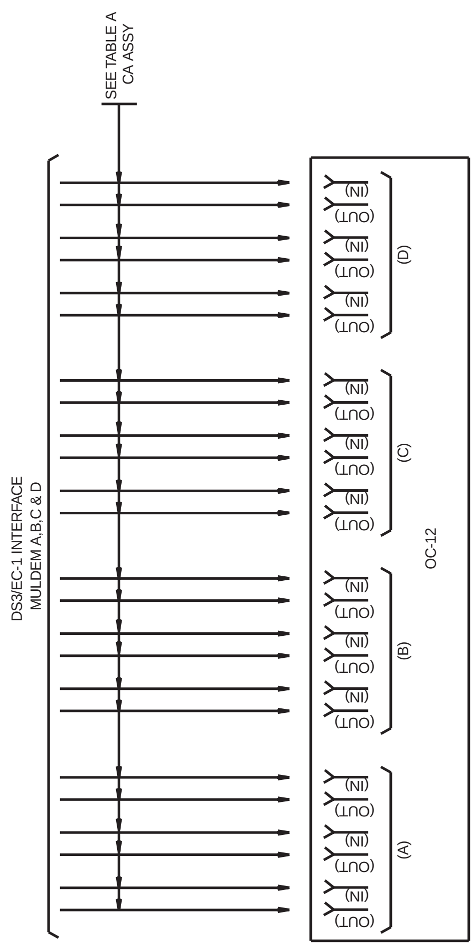


Figure 7-3-4 DS3/EC-1 Transmission Cable

TABLE A (OC-12 COAXIAL CABLE APPLICATIONS FOR REAR ACCESS CABLING COMBINED)

APPLICATION		CABLE TYPE****	ED8C900-12 *	MAXIMUM LENGTH	REMARKS
DSX-3,DSX 3/4, STSX-1		735A (BNC-BNC)†		250 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		250 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
DACS III-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC)†		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821AE-BNC)‡		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (9821AE-BNC)‡		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D-735A (9821AE-BNC)‡		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
DACS IV-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC)†		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821EA-BNC) ‡ (OUT)		500 FT MAX	THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		735A (9821FA-BNC) ‡ (IN)			THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		1735006A (9821EA/FA-BNC)‡		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF**
		735A 734D 735A (9821EA-BNC) ‡ (OUT)		900 FT MAX	THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		735A 734D 735A (9821FA-BNC) ‡ (IN)			THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF

* ED-8C900-12 HAS REPLACED ED-8C900-20 FOR ALL DS3/EC-1 ORDERING.
CABLES IN THIS DRAWING ARE SORTED BY CONNECTOR TYPES.
** - EACH 1735006A CABLE CONTAINS 6 COAXIAL CABLES WITH ASSOCIATED CONNECTORS.
*** - THE G( ), DBD, 1LA CONSISTS OF A SHORT LENGTH OF 735A CABLE SPLICED TO 734D CABLE. THIS GROUP ALLOWS EASIER CONNECTION TO THE OC-12.
THE G( ), DB, 1LA MAY BE USED BUT IS NOT RECOMMENDED DUE TO THE PHYSICAL CONGESTION ON THE OC-12 BACKPLANE.
†- STRAIGHT AND RIGHT ANGEL
‡ - RIGHT ANGLE ONLY

Figure 7-3-5 DS3/EC-1 Transmission Cable

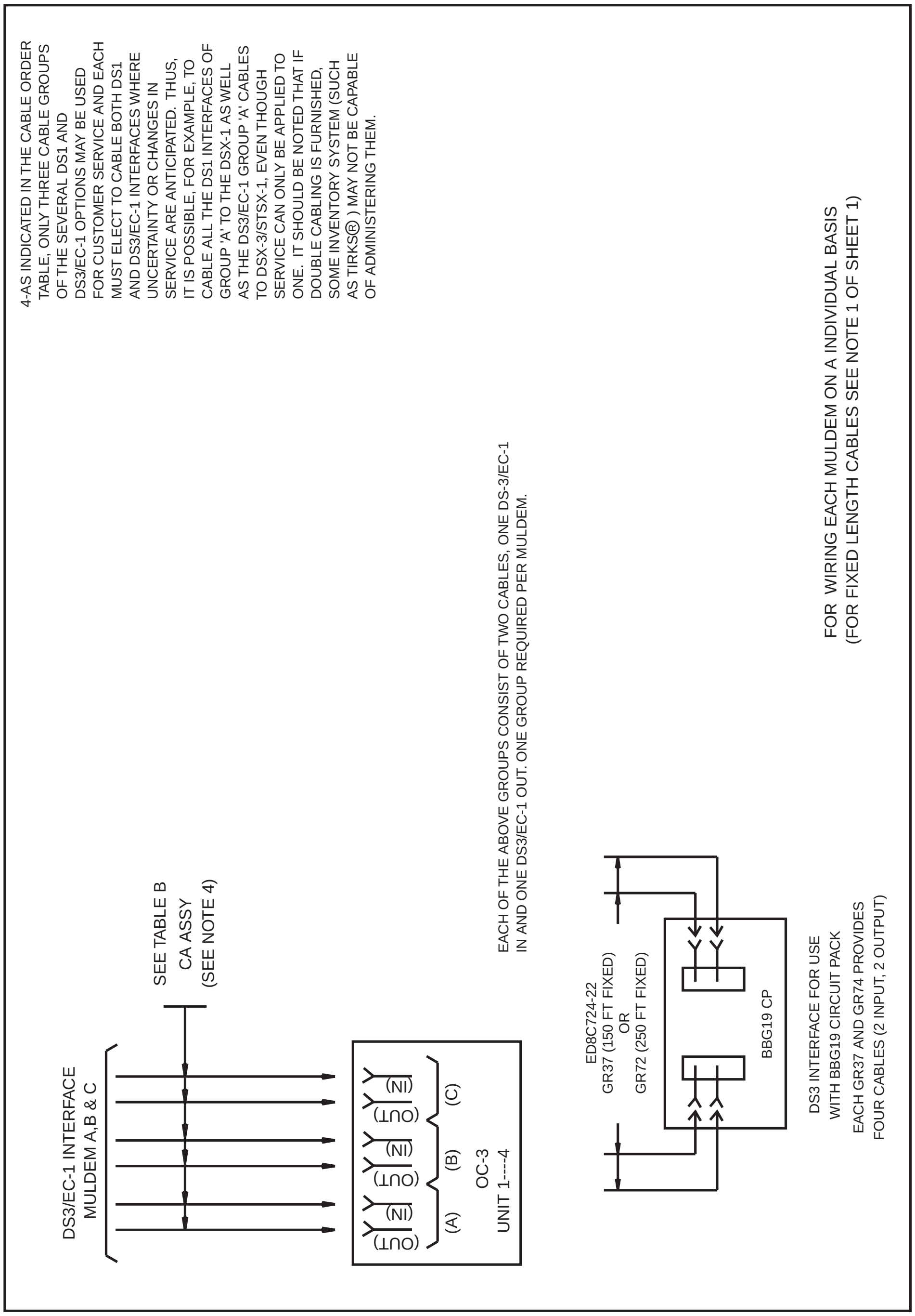


Figure 7-3-7 DS3/EC-1 TRANSMISSION CABLE

Figure 7-3-6 DS3/EC-1 Transmission Cable

TABLE B (OC-3 COAXIAL CABLE APPLICATIONS FOR REAR ACCESS CABLING COMBINED)

APPLICATION		CABLE TYPE***	ED8C900-12 *	MAXIMUM LENGTH	REMARKS
DSX-3,DSX 3/4, STSX-1		735A (BNC-BNC) †		250 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC) †		250 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC) †		450 FT MAX	MAX SIX CABLES PER SHELF
DACS III-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC) †		500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC) †		500 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC) †		900 FT MAX	MAX SIX CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821AE- BNC) ‡		500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (9821AE-BNC) ‡		500 FT MAX	ONE CABLE PER SHELF **
		734D (9821AE-BNC) ‡		900 FT MAX	MAX SIX CABLES PER SHELF
DACS IV-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC) †		500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC) †		500 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC) †		900 FT MAX	MAX SIX CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821EA-BNC) ‡ (OUT)		500 FT MAX	THREE CABLES MAX PER SHELF
		735A (9821FA-BNC) ‡ (IN)			THREE CABLES MAX PER SHELF
		1735006A (9821EA/F A-BNC) ‡		500 FT MAX	ONE CABLE MAX PER SHELF
		734D (9821EA-BNC) (OUT) ‡		900 FT MAX	THREE CABLES MAX PER SHELF
		734D (9821FA-BNC) (IN) ‡			THREE CABLES MAX PER SHELF

* - ED-8C900-12 HAS REPLACED ED-8C900-20 FOR ALL DS3/EC-1 ORDERING.
CABLES IN THIS DRAWING ARE SORTED BY CONNECTOR TYPES.
** - EACH 1735006A CABLE CONTAINS 6 COAXIAL CABLES WITH ASSOCIATED CONNECTORS.
† - STRAIGHT AND RIGHT ANGLE
‡ - RIGHT ANGLE ONLY

Figure 7-3-7 DS3/EC-1 Transmission Cable

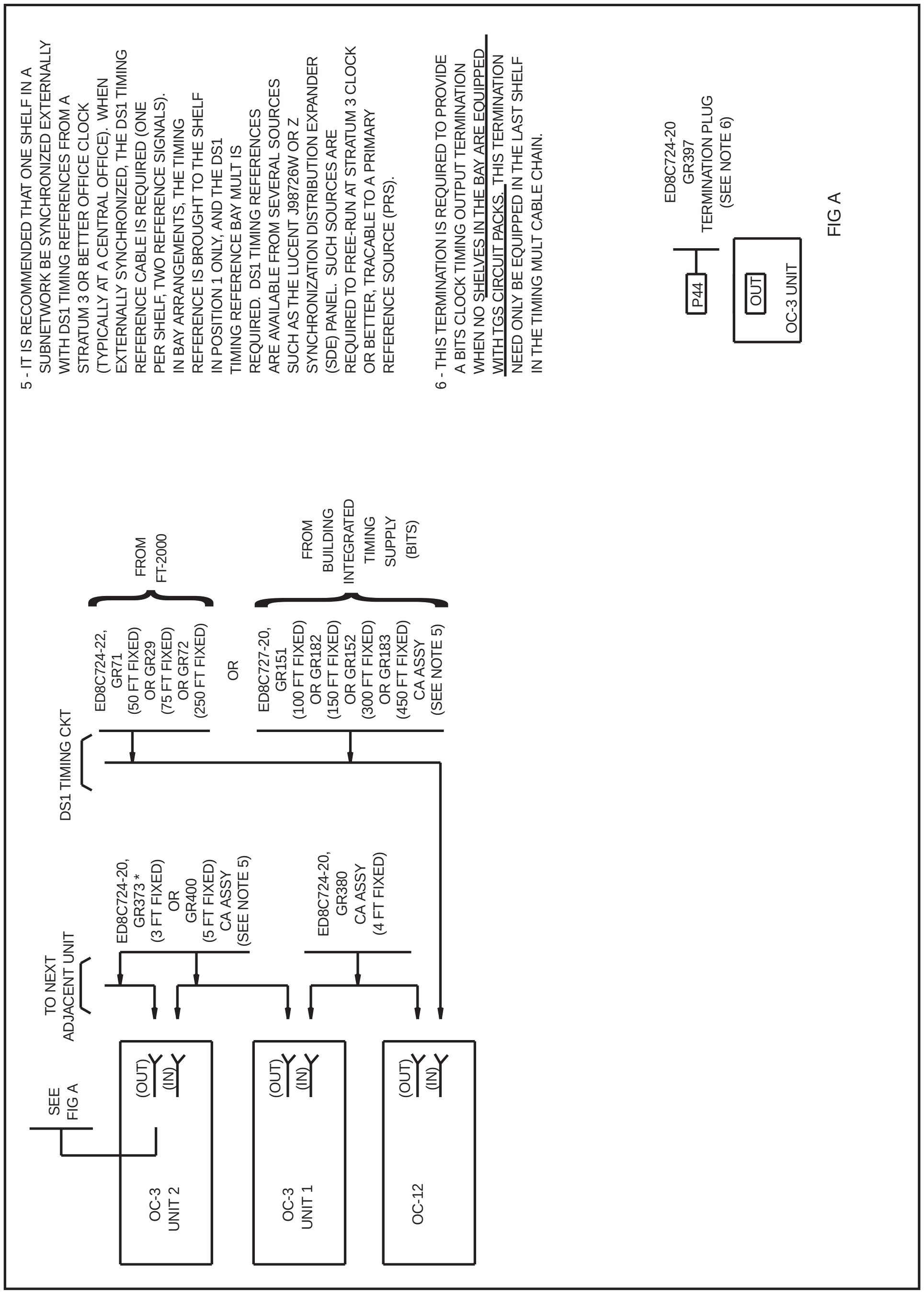


Figure 7-3-8 DS1 Timing Reference Interface and Mult Cable

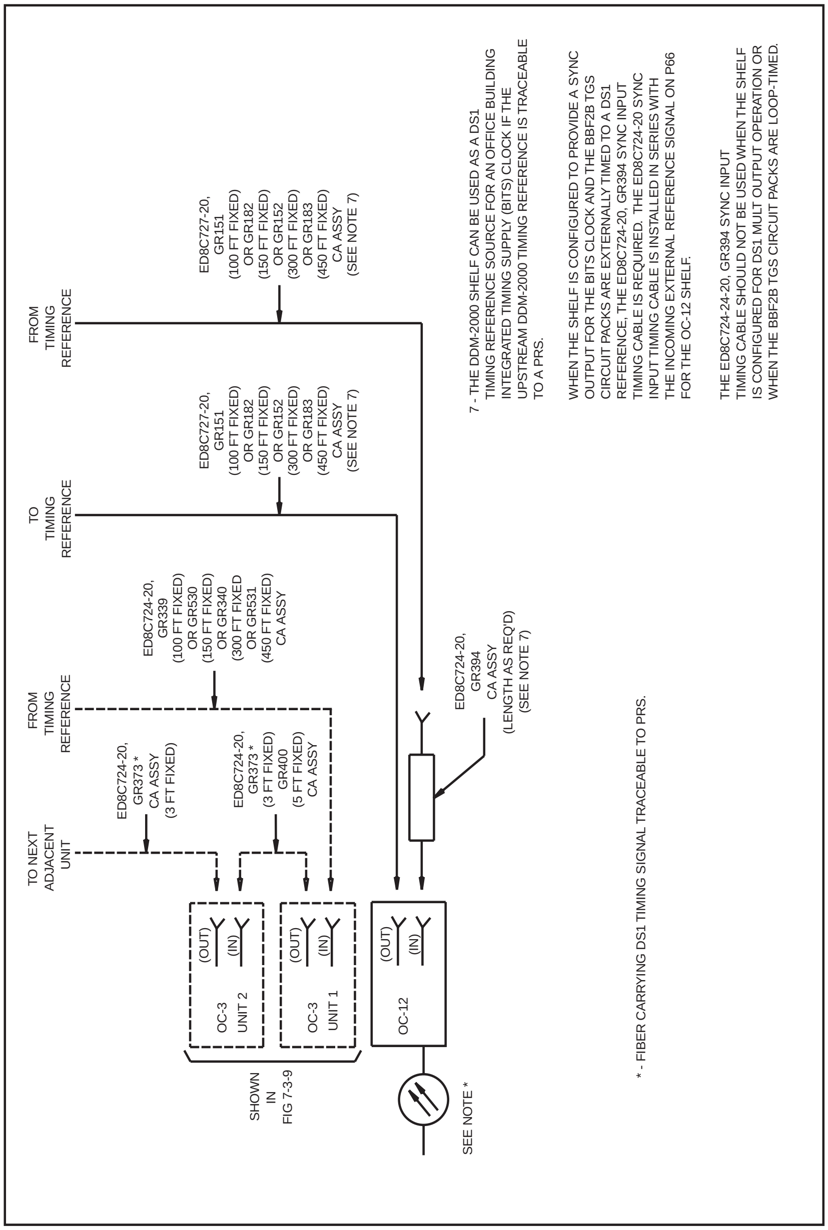


Figure 7-3-9 Synchronization for Timing Distribution in a Bay Arrangement

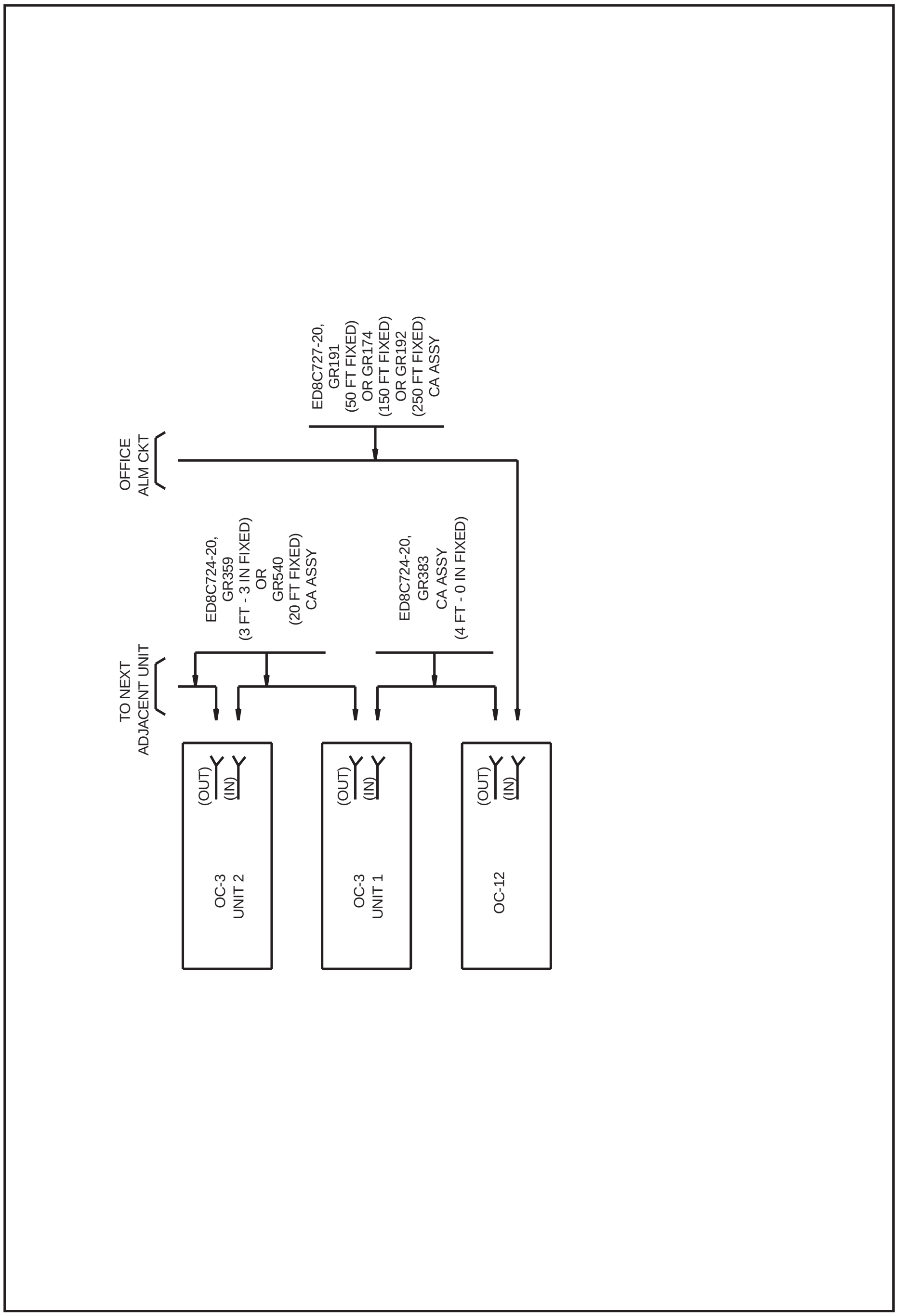


Figure 7-3-10 Office Alarm Interface and Mult Cable

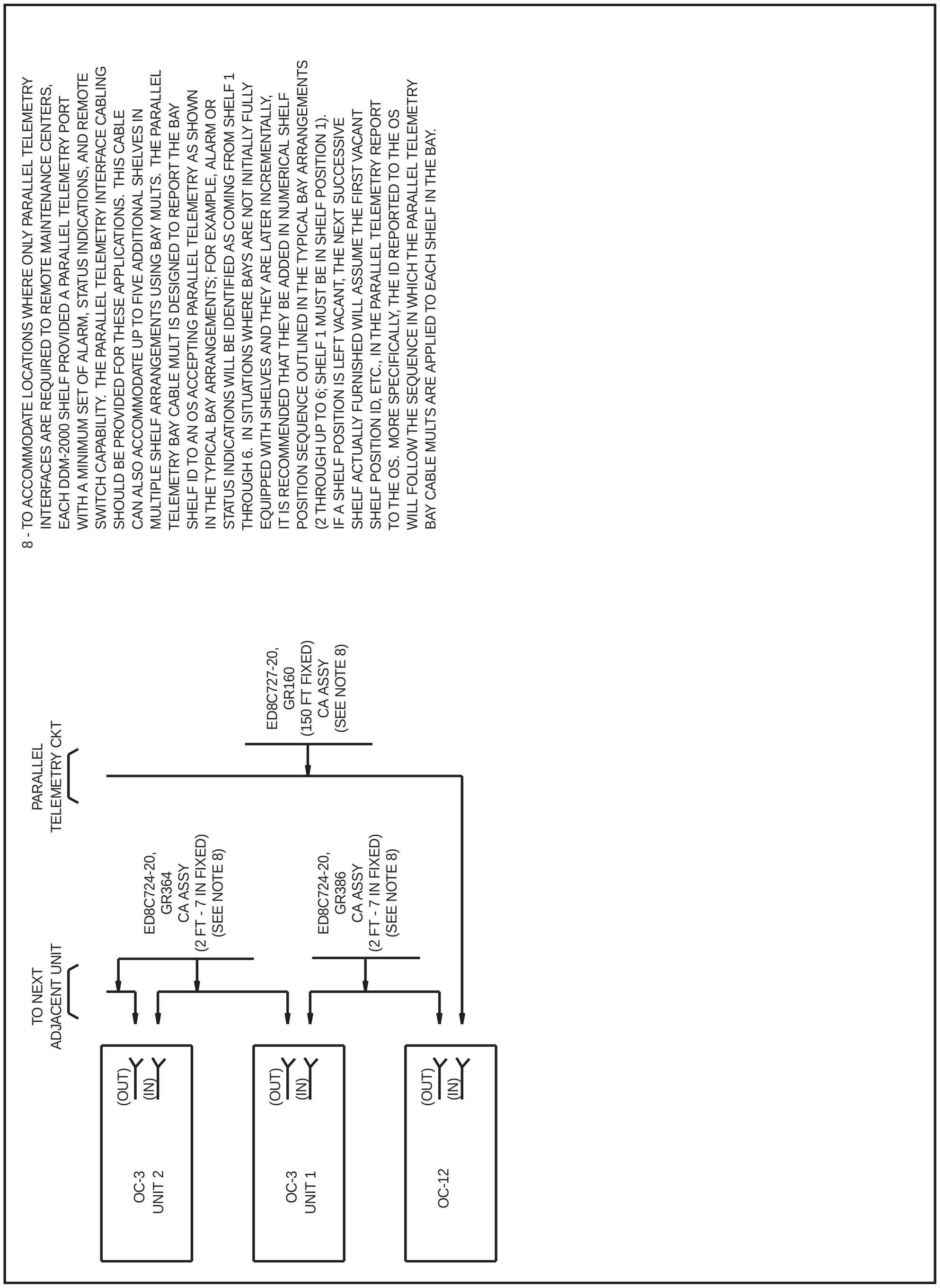


Figure 7-3-11 Parallel Telemetry Interface and Mult Cable

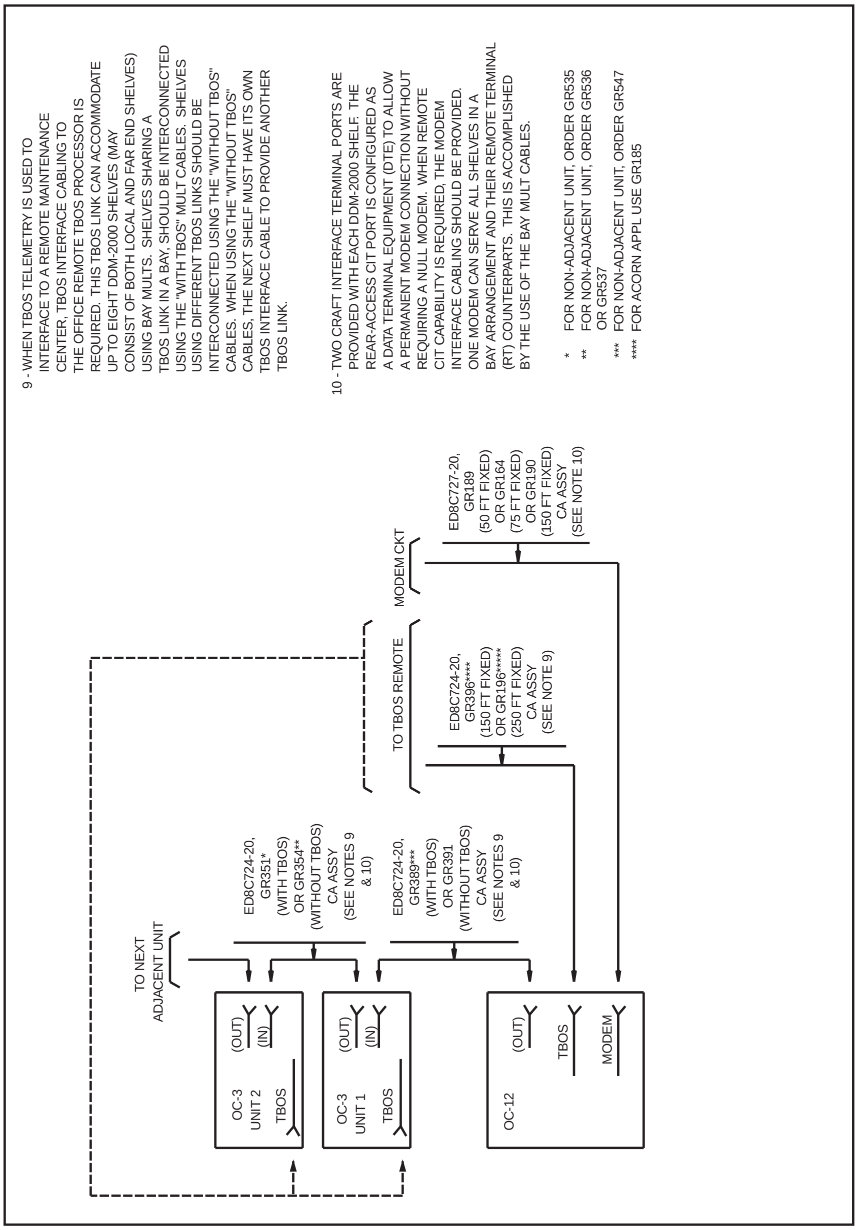


Figure 7-3-12 Modem, TBOS Interface, and Bay Mult Cable for TBOS, CIT, and Modem

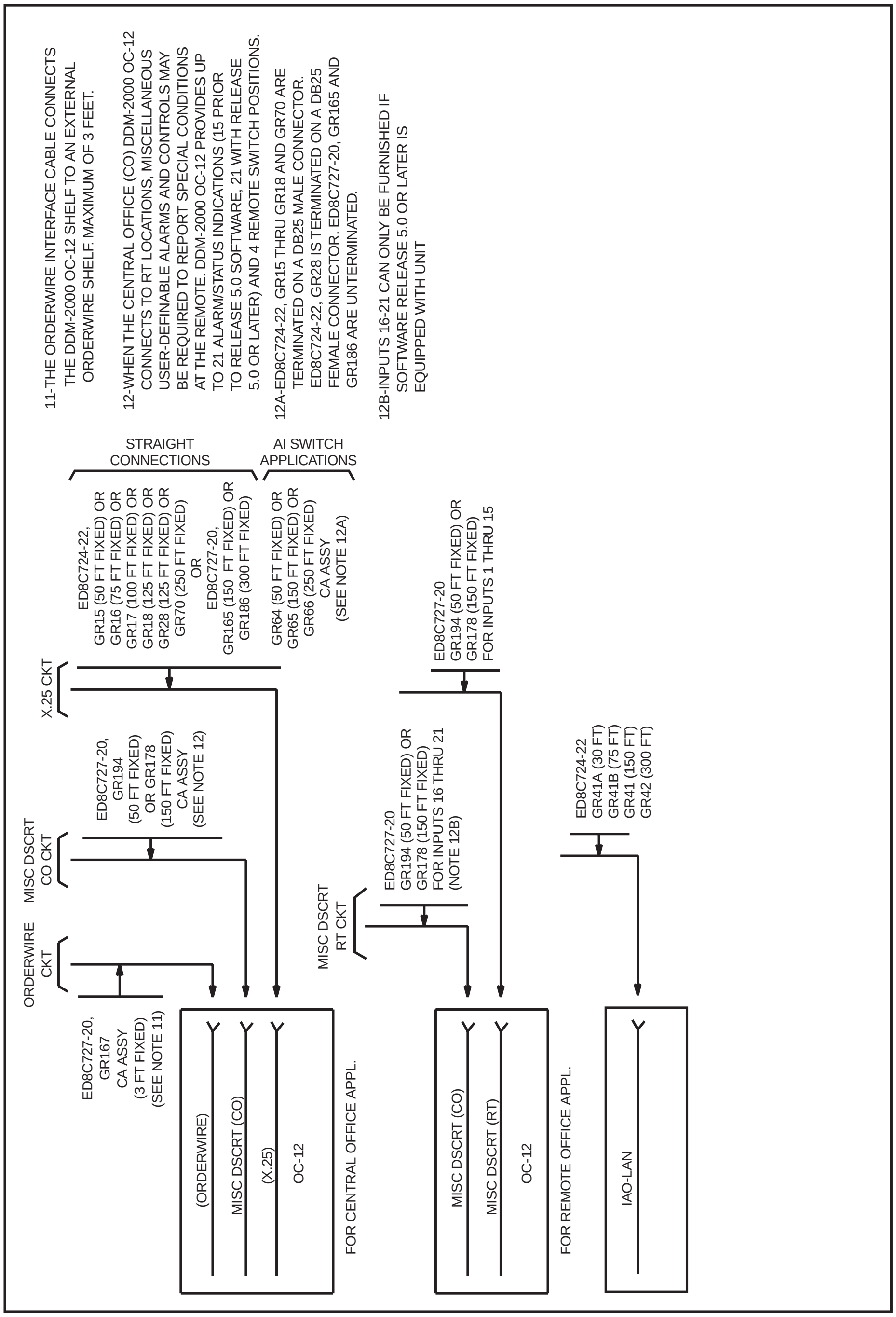


Figure 7-3-13 X.25 Interface, Miscellaneous Discretes, Orderwire, and LAN

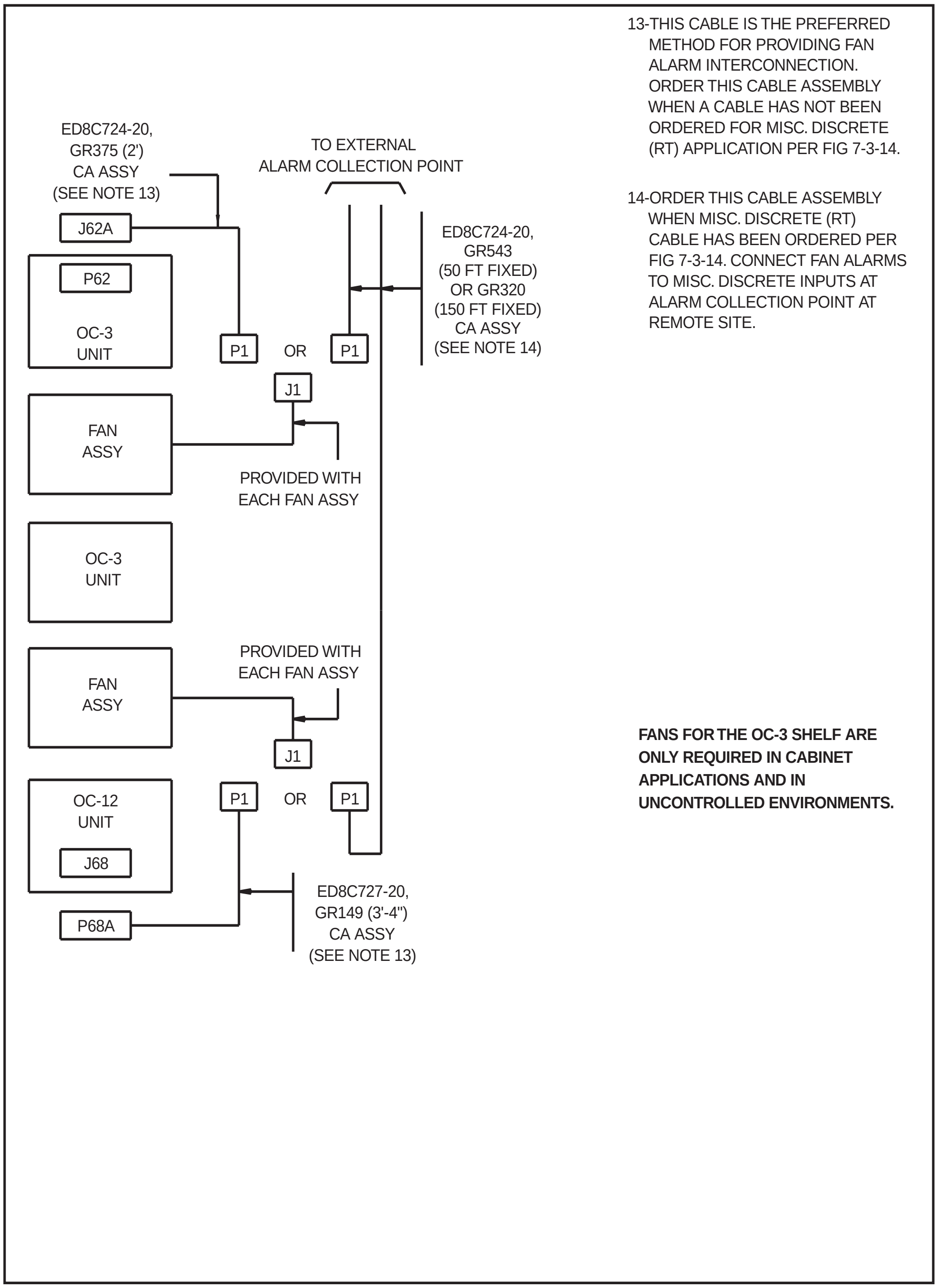


Figure 7-3-14 Alarm Cable for Fan Shelf

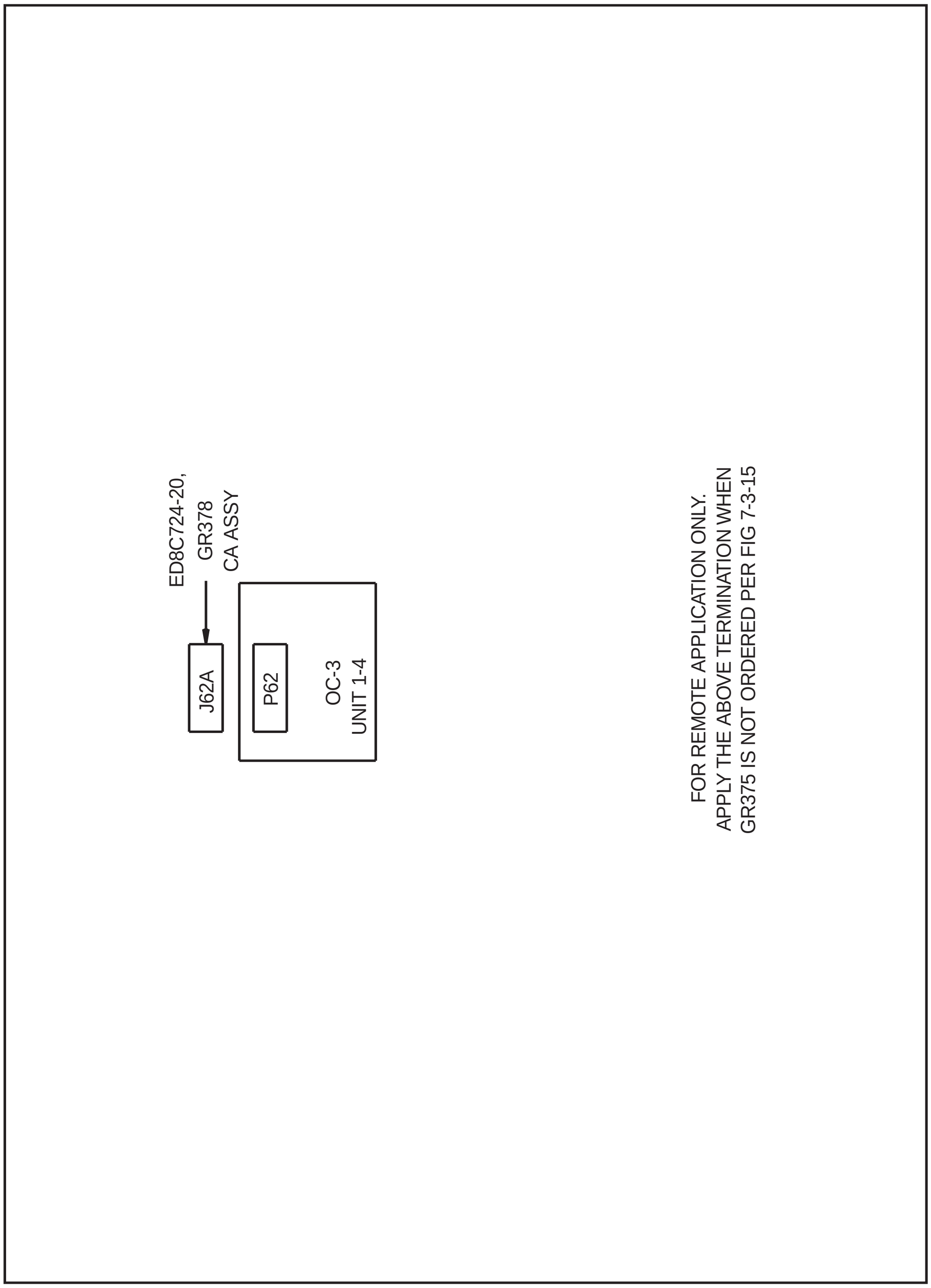


Figure 7-3-15 Fan Alarm Ground Assembly

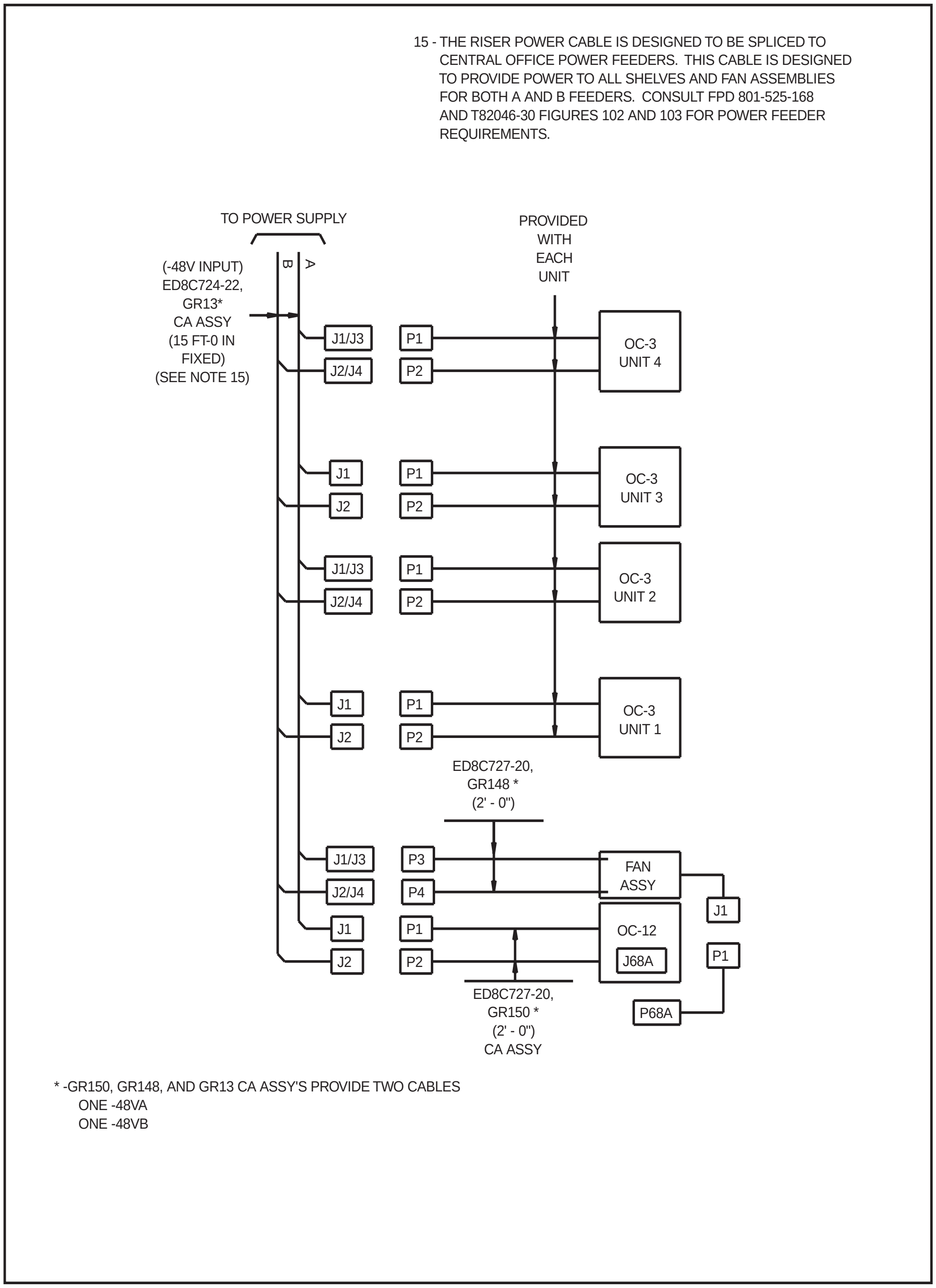


Figure 7-3-16 Power Input Cable for Bay Arrangement of OC-3/OC-12 Rear Access Units

OC-3/OC-12 REAR ACCESS CABLE ORDER BLANK (SHEET 1 OF 7)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
DS1 26-Gauge Wire Application, One Group Required per MULDEM	7-3-2	ED8C724-22	4 or	100	1	1		DS1 Interface MULDEM A Length ≥ 30 Feet
	7-3-2		43	250				
	7-3-2	ED8C724-20	304 or	75				
	7-3-2		305 or	150				
	7-3-2		512 or	30				
	7-3-2		513 or	350				
	7-3-2		514	450				
	7-3-2	ED8C724-22	5 or	100	1	1		DS1 Interface MULDEM B Length ≥ 30 Feet
	7-3-2		44	250				
	7-3-2	ED8C724-20	310 or	75				
	7-3-2		311 or	150				
	7-3-2		517 or	30				
	7-3-2		518 or	350				
	7-3-2		519	450				
	7-3-2	ED8C724-22	6 or	100	1	1		DS1 Interface MULDEM C Length ≥ 30 Feet
	7-3-2		45	250				
	7-3-2	ED8C724-20	316 or	75				
	7-3-2		317 or	150				
	7-3-2		522 or	30				
	7-3-2		523 or	350				
	7-3-2		524	450				
For DS1 Applications of ≤ 20 Feet	7-3-2	846881621				4		MULDEM A, B, or C With Length ≤ 20 Feet (4/MULDEM)
	7-3-2	ED8C724-21	450			1		MULDEM A Required for Each Application of 846881621
	7-3-2		451			1		MULDEM B
	7-3-2		452			1		MULDEM C

OC-3/OC-12 REAR ACCESS CABLE ORDER BLANK (SHEET 2 OF 7)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
DS1 22-Gauge Wire Application One Group Required Per MULDEM	7-3-3	ED8C724-22	1 or	100		1		DS1 Interface MULDEM A Length ≥ 30 Feet
	7-3-3		75	250				
	7-3-3	ED8C724-20	301 or	75				
	7-3-3		302 or	150				
	7-3-3		510 or	350				
	7-3-3		511	450				
	7-3-3	ED8C724-22	2 or	100		1		DS1 Interface MULDEM B Length ≥ 30 Feet
	7-3-3		76	250				
	7-3-3	ED8C724-20	307 or	75				
	7-3-3		308 or	150				
	7-3-3		515 or	350				
	7-3-3		516	450				
	7-3-3	ED8C724-22	3 or	100		1		DS1 Interface MULDEM C Length ≥ 30 Feet
	7-3-3		77	250				
	7-3-3	ED8C724-20	313 or	75				
	7-3-3		314 or	150				
	7-3-3		520 or	350				
	7-3-3		521	450				

OC-3/OC-12 REAR ACCESS CABLE ORDER BLANK (SHEET 3 OF 7)

Fig. Description	Fig.	Code	Group/ Comcode Num	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
735A Cable for DS3/EC-1 Applications When Wiring Each MULDEM on an Individual Basis (OC-12 Shelf)	7-3-4/ 7-3-5	ED8C900-12	108799651* (Table 1V)	150	24			Note 1 Six Groups (cables) Required per MULDEM
735A Cable for DS3/EC-1 Applications When Wiring Each MULDEM on an Individual Basis (OC-3 Shelf)	7-3-6/ 7-3-7	ED8C900-12	108799651* (Table 1V)	150		6		Note 1 Two Groups (cables) Required per MULDEM
735A Cable for DS3 Interface with BBG19	7-3-6/ 7-3-7	ED8C724-22	37 or	150	1	1		One Group Required per MULDEM
	7-3-6/ 7-3-7		74	250				
1735006A Cable for DS3/EC-1 Applications When all Three MULDEMs are Wired at the Same Time (OC-12 Shelf)	7-3-4/ 7-3-5	ED8C900-12	108811845* (Table 4V)	150	4			Note 1

* Right angle BNC — loose straight BNC.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

Note 2: One end has no connector. Order with comcode 407772235 for straight BNC. See Table 7A from ED-8C900-12 for other connector types.

OC-3/OC-12 REAR ACCESS CABLE ORDER BLANK (SHEET 4 OF 7)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
734D Cable for DS3/EC-1 Applications When Cable Length Exceeds the 735 Type Cable Requirements (OC-12 Shelf)	7-3-4/ 7-3-5	ED8C900-12	108817800** (Table 6G)	300	24			Notes 1 and 3 Six Groups (cables) Required per MULDEM
734D Cable for DS3/EC-1 Applications When Cable Length Exceeds the 735 Type Cable Requirements (OC-3 Shelf)	7-3-6/ 7-3-7	ED8C900-12	108818048*** (Table 6H)	300		6		Notes 1 and 2 Two Groups (cables) Required per MULDEM

** Straight BNC — no connector.
*** Right angle BNC — no connector.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

Note 2: One end has no connector. Order with comcode 407772235 for straight BNC. See Table 7A from ED-8C900-12 for other connector types.

Note 3: One end has no connector. Order ED-7G001-23, G604, 13-foot pigtail equipped with right angle BNC.

OC-3/OC-12 REAR ACCESS CABLE ORDER BLANK (SHEET 5 OF 7)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
DS1 Timing Input and MULT Cable Required Between Adjacent Units	7-3-8	ED8C724-22	71 or	50				
	7-3-8		29 or	75	1			From FT-2000
	7-3-8		72	250				
	7-3-8	ED8C727-20	151 or	100				From BITS
	7-3-8		152 or	300				
	7-3-8		182 or	150				
	7-3-8		183	450				
	7-3-8	ED8C724-20	380		1			
	7-3-8		373 or			1		
	7-3-8		400	5				
	7-3-8		397			A/R		See Fig. 7-3-8, Fig. A
Synchronization for Timing Distribution Cable in a Bay Arrangement	7-3-9	ED8C727-20	151 or	100	2			
	7-3-9		152 or	300				
	7-3-9		182 or	150				
	7-3-9		183	450				
	7-3-9	ED8C724-20	394		1			
	7-3-9		373 or			1		As Required per Fig. 7-3-8
	7-3-9		400	5				
	7-3-9		339	100		See Note		As Required per Fig. 6
	7-3-9		340	300				
	7-3-9		530	150				
	7-3-9		531	450				
	7-3-9		397			A/R		See Fig. 7-3-8, Fig. A
Office Alarm Interface and MULT Cable Required Between Adjacent Units	7-3-10	ED8C727-20	174 or	150	1			
	7-3-10		191 or	50				
	7-3-10		192	250				
	7-3-10	ED8C724-20	383		1			
	7-3-10		359 or			1		
	7-3-10		540	20				For Nonadjacent Units

OC-3/OC-12 REAR ACCESS CABLE ORDER BLANK (SHEET 6 OF 7)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes	
Parallel Telemetry Interface and MULT Cable Required Between Adjacent Units	7-3-11	ED8C727-20	160	150	1				
	7-3-11	ED8C724-20	386		1				
	7-3-11		364			1			
Modem, TBOS Interface and MULT Cable for TBOS and Bay MULT Wiring Between Adjacent Units	7-3-12	ED8C727-20	164 or	75	1			MODEM	
	7-3-12		189 or	50					
	7-3-12		190	150					
	7-3-12		157 or	150	1	A/R		TBOS	For (AT&T) ACORN Applications
	7-3-12		185 or	300					
	7-3-12	ED8C727-20	195 or	150					For Non-ACORN Applications
	7-3-12		196	250					
	7-3-12	ED8C724-20	389 or		1				With TBOS
	7-3-12		547 or						Nonadjacent Unit
	7-3-12		391	20					Without TBOS; Order 4-Foot Length if Units are Adjacent
	7-3-12		351 or			1		With TBOS	
	7-3-12		535 or	4.17					Nonadjacent Unit
	7-3-12		354 or					Without TBOS	
	7-3-12		536 or	4.17					Nonadjacent Unit
	7-3-12		537	20					

OC-3/OC-12 REAR ACCESS CABLE ORDER BLANK (SHEET 7 OF 7)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes	
X.25 Interface, Miscellaneous Discretes, Orderwire, and IAO LAN Cables as Required for each OC-12 Unit	7-3-13	ED8C727-20	165 or	150	1	1		X.25	Unterminated
	7-3-13		186 or	300					
	7-3-13	ED8C724-22	15 or	50					Terminated on Male Connector
	7-3-13		16 or	75					
	7-3-13		17 or	100					
	7-3-13		18 or	125					
	7-3-13		70 or	250					
	7-3-13		28	125					Term. on Female Conn.
	7-3-13		64	50				AI Switch	
	7-3-13		65	150					
	7-3-13		66	250					
	7-3-13		41A or	30	A/R	A/R		IAO LAN	R7.0
	7-3-13		41B or	75					
	7-3-13		41 or	150					
	7-3-13		42	300					
	7-3-13	ED8C727-20	167		1	1		Orderwire	
	7-3-13		178 or		1 or 2	1 or 2		Miscellaneous Discrete 1 — Points 1-15 1 — Inputs 16-21 (RT Only)	
	7-3-13		194	50					
Cable Assembly for Fan Alarm	7-3-14	ED8C727-20	149		1				
	7-3-14	ED8C724-20	320	150		1			
	7-3-14		543	50					
	7-3-14		375					One Per OC-3 Fan Assembly	
For Remote Applications Only, Apply This Termination When GR375 is not Ordered Per Fig. 7-3-14	7-3-15	ED8C724-20	378			A/R		See Fig. 7-3-16	
Power Input Cable for Bay Arrangement of OC-3/OC-12 Rear Access Units	7-3-16	ED8C724-22	13		1			Power Riser	
	7-3-16	ED8C727-20	148		1			Fan Power (OC-12)	
	7-3-16		150		1			Shelf Power (OC-12)	

DDM-2000 OC-3/OC-12 Front Access Cabling Combined

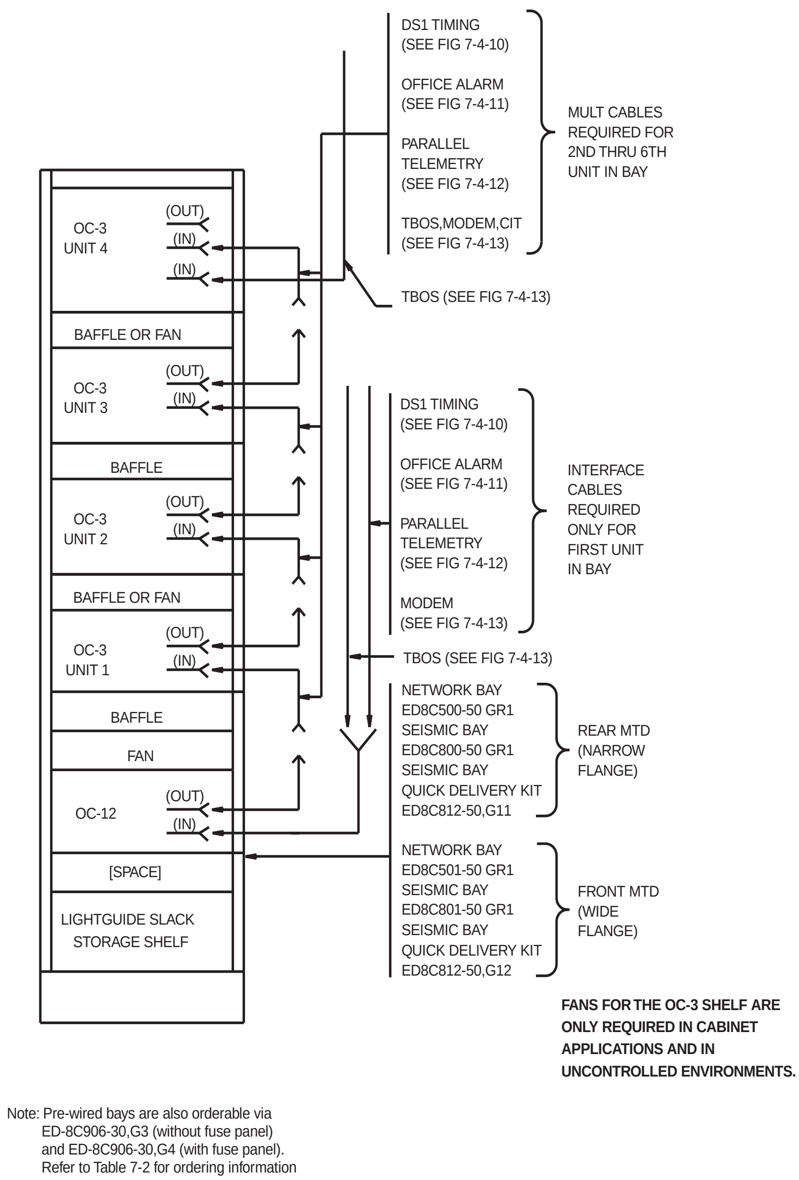


Figure 7-4-1 Typical Bay Arrangement for DDM-2000 Initial Growth Bay OC-3/OC-12 Front Access

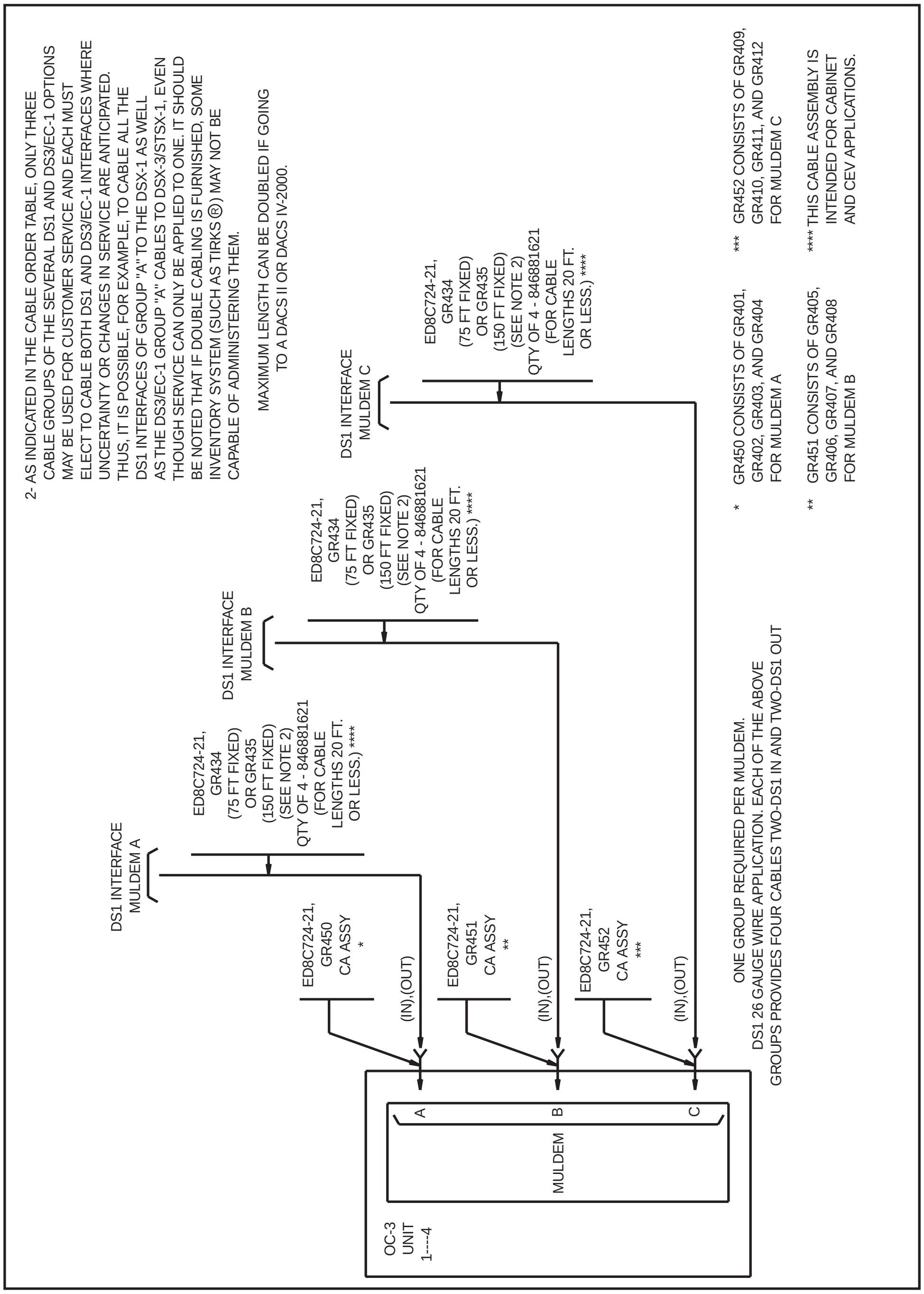


Figure 7-4-2 DS1 Transmission Cables — 26 Gauge

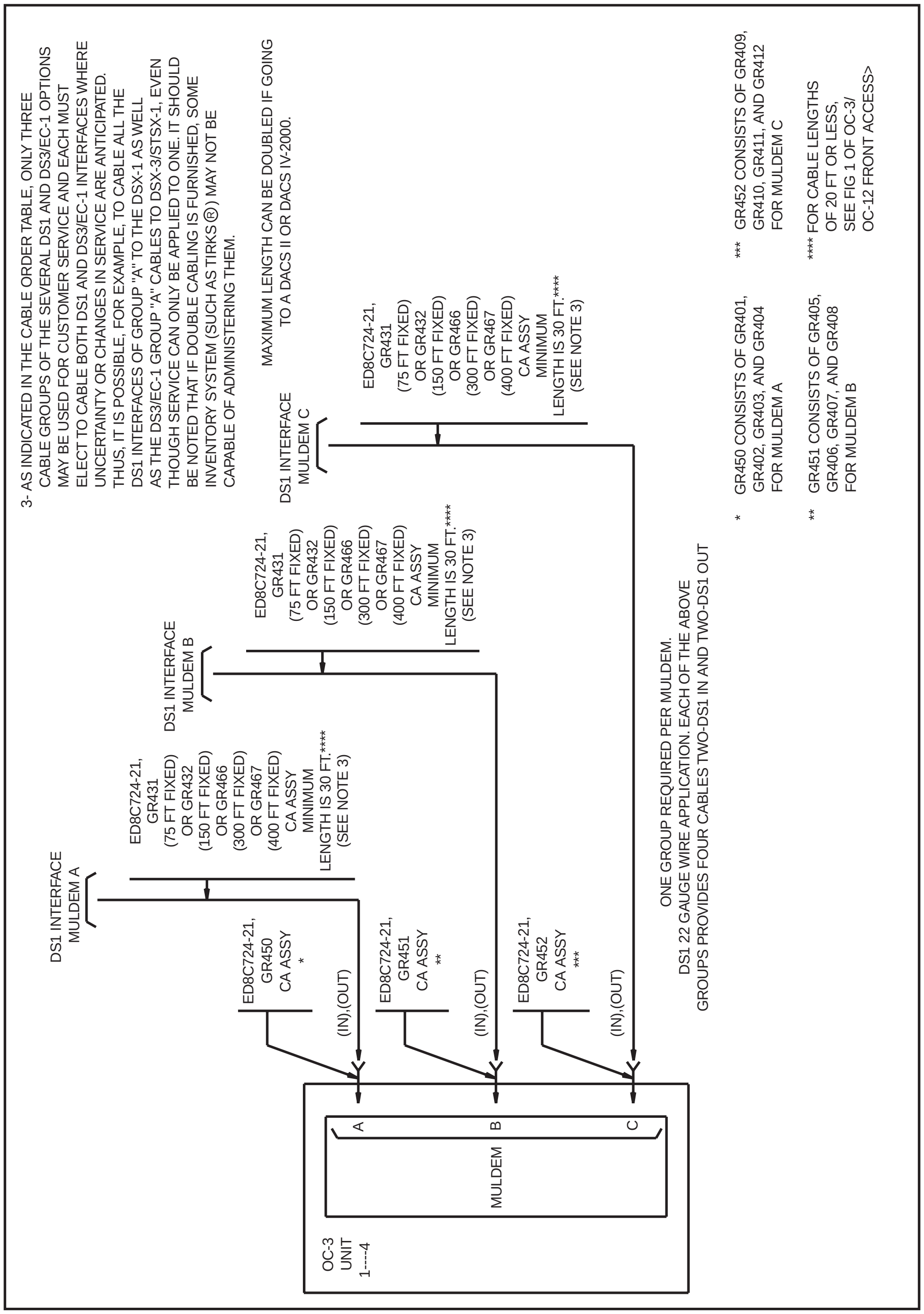


Figure 7-4-3 DS1 Transmission Cables — 22 Gauge

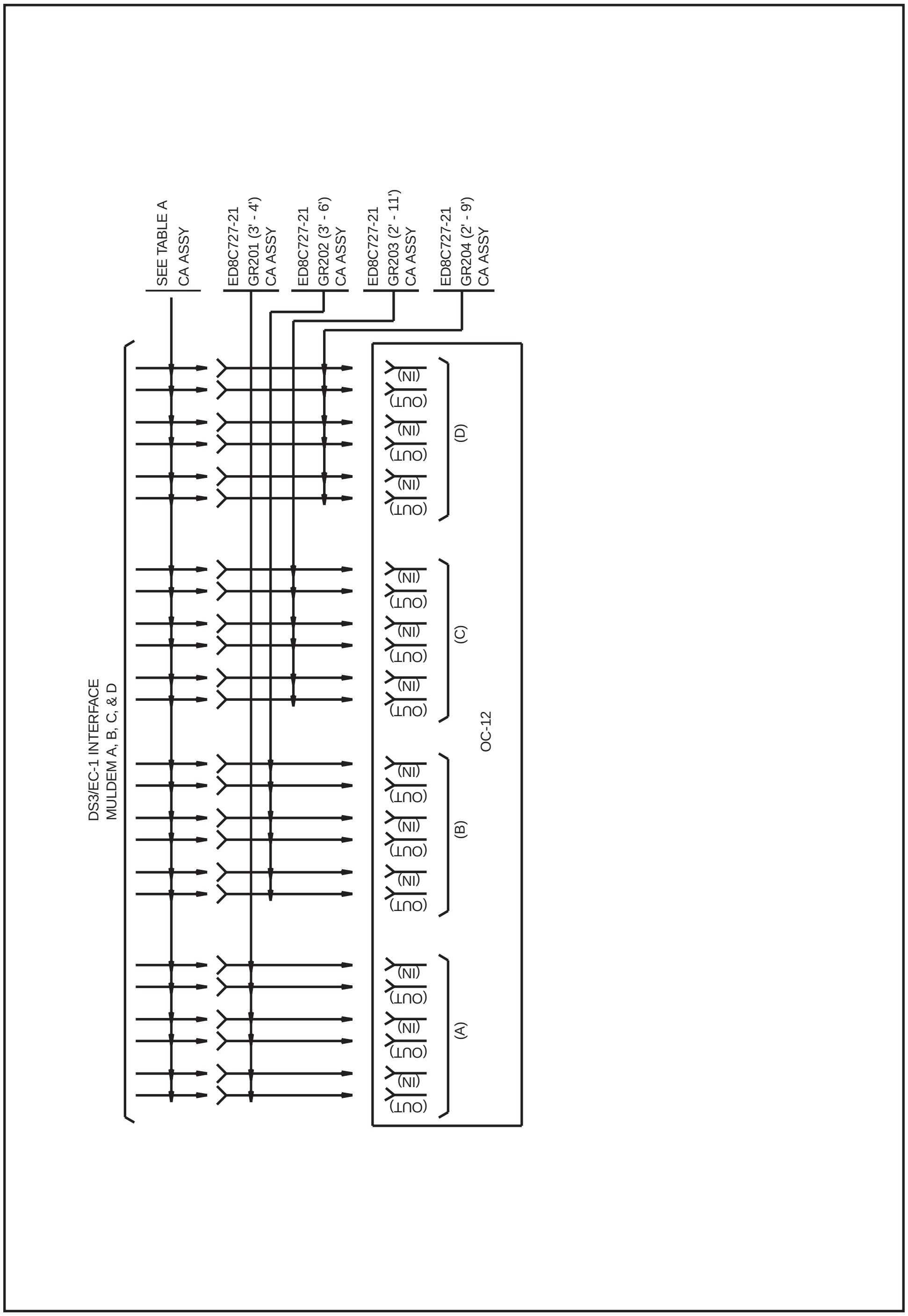


Figure 7-4-4 DS3/EC-1 Transmission Cable

TABLE A (OC-12 COAXIAL CABLE APPLICATIONS FOR FRONT ACCESS CABLING COMBINED)

APPLICATION		CABLE TYPE****	ED8C900-12 *	MAXIMUM LENGTH	REMARKS
DSX-3,DSX 3/4, STSX-1		735A (BNC-BNC)†		250 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		250 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
DACS III-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC)†		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821AE-BNC)‡		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (9821AE-BNC)‡		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D-735A (9821AE-BNC)‡		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
DACS IV-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC)†		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821EA-BNC) ‡ (OUT)		500 FT MAX	THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		735A (9821FA-BNC) ‡ (IN)			THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		1735006A (9821EA/FA-BNC)‡		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF**
		735A 734D 735A (9821EA-BNC) ‡ (OUT)		900 FT MAX	THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		735A 734D 735A (9821FA-BNC) ‡ (IN)			THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF

* - ( ) INDICATES GROUP FOR CABLE TYPE AND LENGTH TO BE SHIPPED PER TABLES IN ADJACENT COLUMN.
** - EACH 1735006A CABLE CONTAINS 6 COAXIAL CABLES WITH ASSOCIATED CONNECTORS.
*** - THE G( ), DBD, 1LA CONSISTS OF A SHORT LENGTH OF 735A CABLE SPLICED TO 734D CABLE. THIS GROUP ALLOWS EASIER CONNECTION TO THE OC-12. THE G( ), DB, 1LA MAY BE USED BUT IS NOT RECOMMENDED DUE TO THE PHYSICAL CONGESTION ON THE OC-12 BACKPLANE.
†- STRAIGHT AND RIGHT ANGEL
‡ - RIGHT ANGLE ONLY

Figure 7-4-5 DS3/EC-1 Transmission Cable

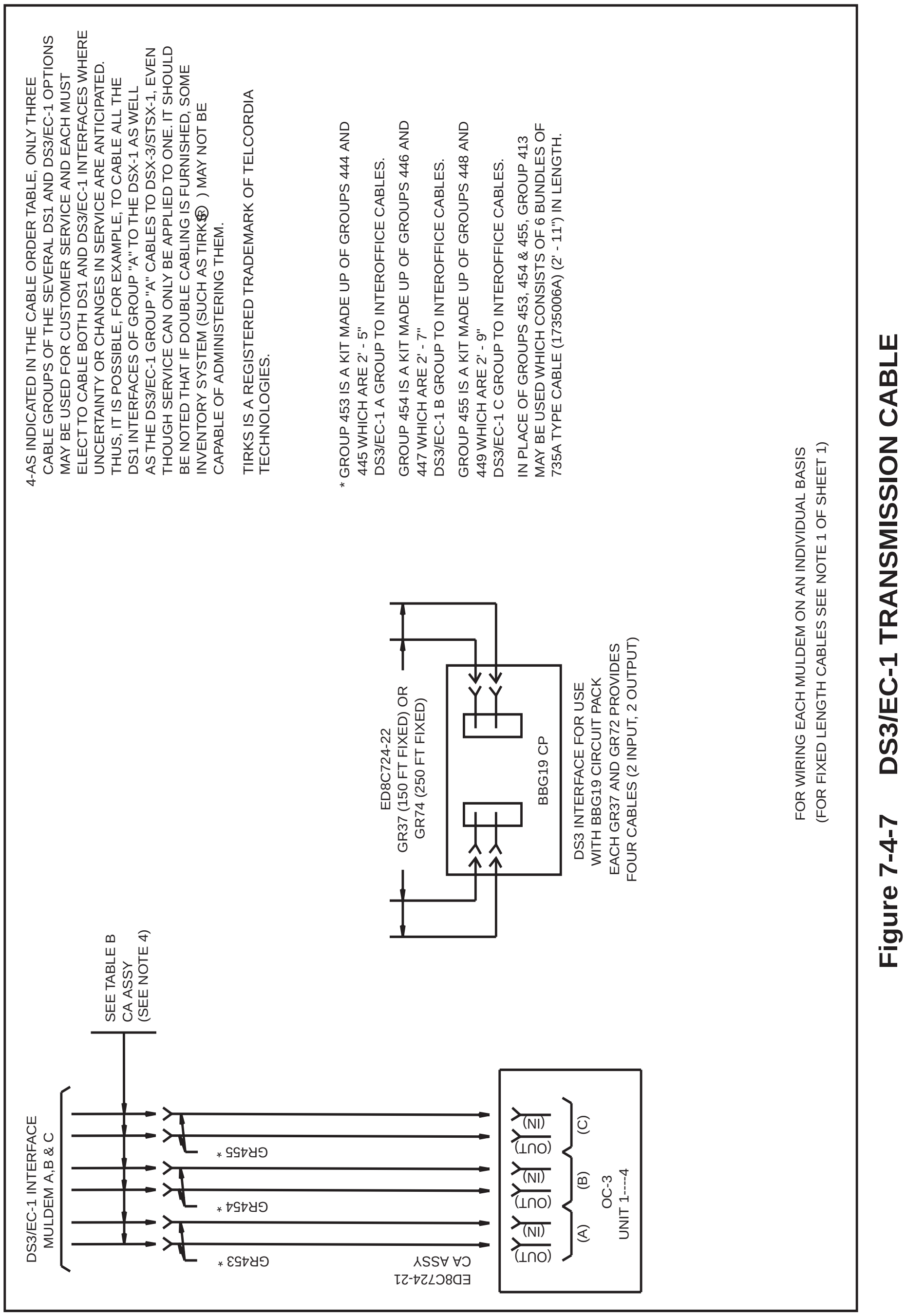


Figure 7-4-6 DS3/EC-1 Transmission Cable

TABLE B (OC-3 COAXIAL CABLE APPLICATIONS FOR FRONT ACCESS CABLING COMBINED)

APPLICATION		CABLE TYPE***		ED8C900-12 *	MAXIMUM LENGTH	REMARKS
DSX-3,DSX 3/4, STSX-1		735A (BNC-BNC) †			250 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC) †			250 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC) †			450 FT MAX	MAX SIX CABLES PER SHELF
DACS III-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC) †			500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC) †			500 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC) †			900 FT MAX	MAX SIX CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821AE- BNC) ‡			500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (9821AE-BNC) ‡			500 FT MAX	ONE CABLE PER SHELF **
		734D (9821AE-BNC) ‡			900 FT MAX	MAX SIX CABLES PER SHELF
DACS IV-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC) †			500 FT MAX	MAX SIX CABLES PER SHELF
		1735006A (BNC-BNC) †			500 FT MAX	ONE CABLE PER SHELF **
		734D (BNC-BNC) †			900 FT MAX	MAX SIX CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A	(9821EA-BNC) ‡ (OUT)		500 FT MAX	THREE CABLES MAX PER SHELF
			(9821FA-BNC) ‡ (IN)			THREE CABLES MAX PER SHELF
		1735006A (9821EA/FA-BNC) ‡			500 FT MAX	ONE CABLE MAX PER SHELF
		734D	(9821EA-BNC) (OUT) ‡		900 FT MAX	THREE CABLES MAX PER SHELF
			(9821FA-BNC) (IN) ‡			THREE CABLES MAX PER SHELF

* - ED-8C900-12 HAS REPLACED ED-8C900-20 FOR ALL DS3/EC-1 ORDERING.
CABLES IN THIS DRAWING ARE SORTED BY CONNECTOR TYPES.
** - EACH 1735006A CABLE CONTAINS 6 COAXIAL CABLES WITH ASSOCIATED CONNECTORS.
† - STRAIGHT AND RIGHT ANGLE
‡ - RIGHT ANGLE ONLY

Figure 7-4-7 DS3/EC-1 Transmission Cable

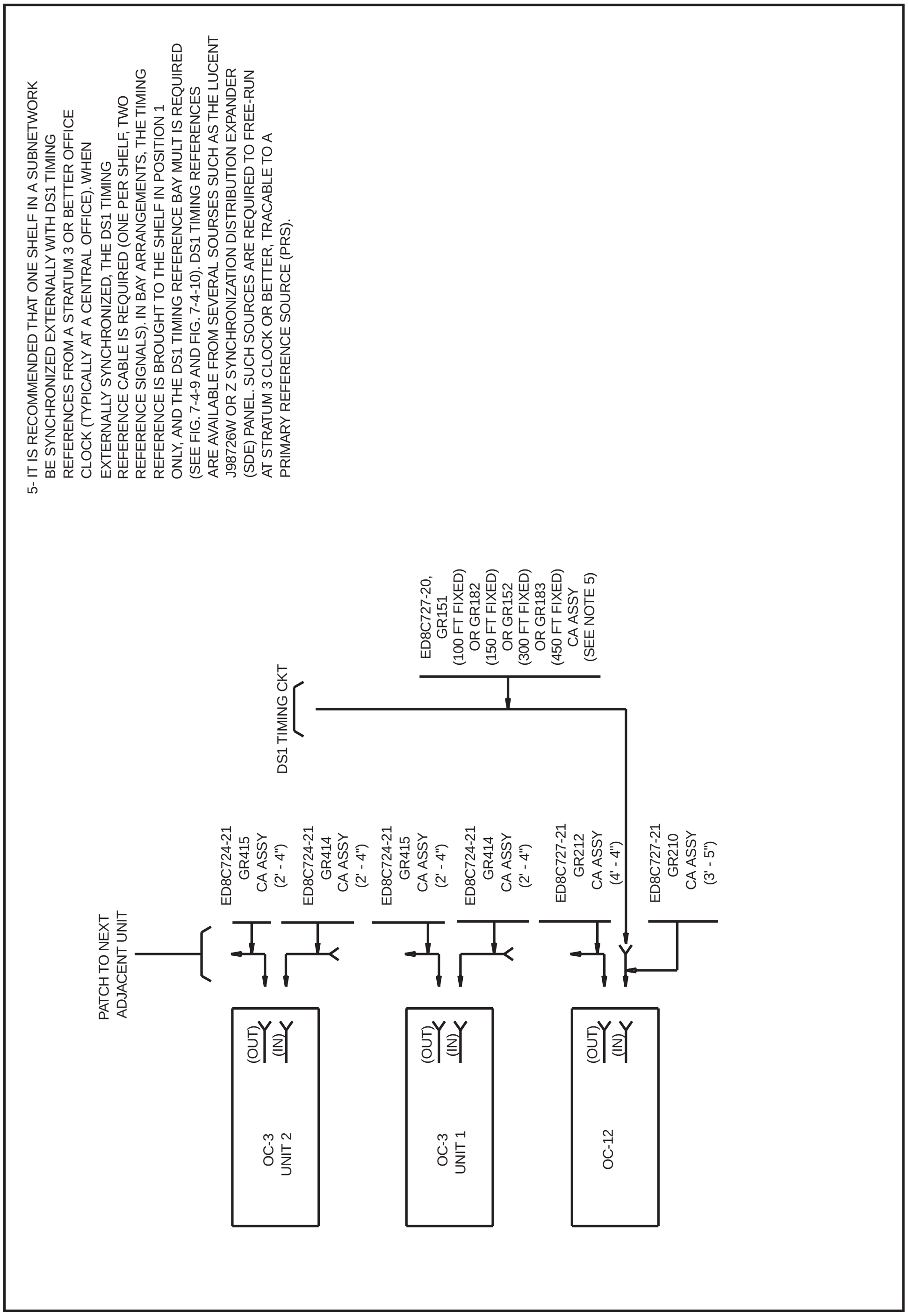


Figure 7-4-8 DS1 Timing Reference Interface and Mult Cable

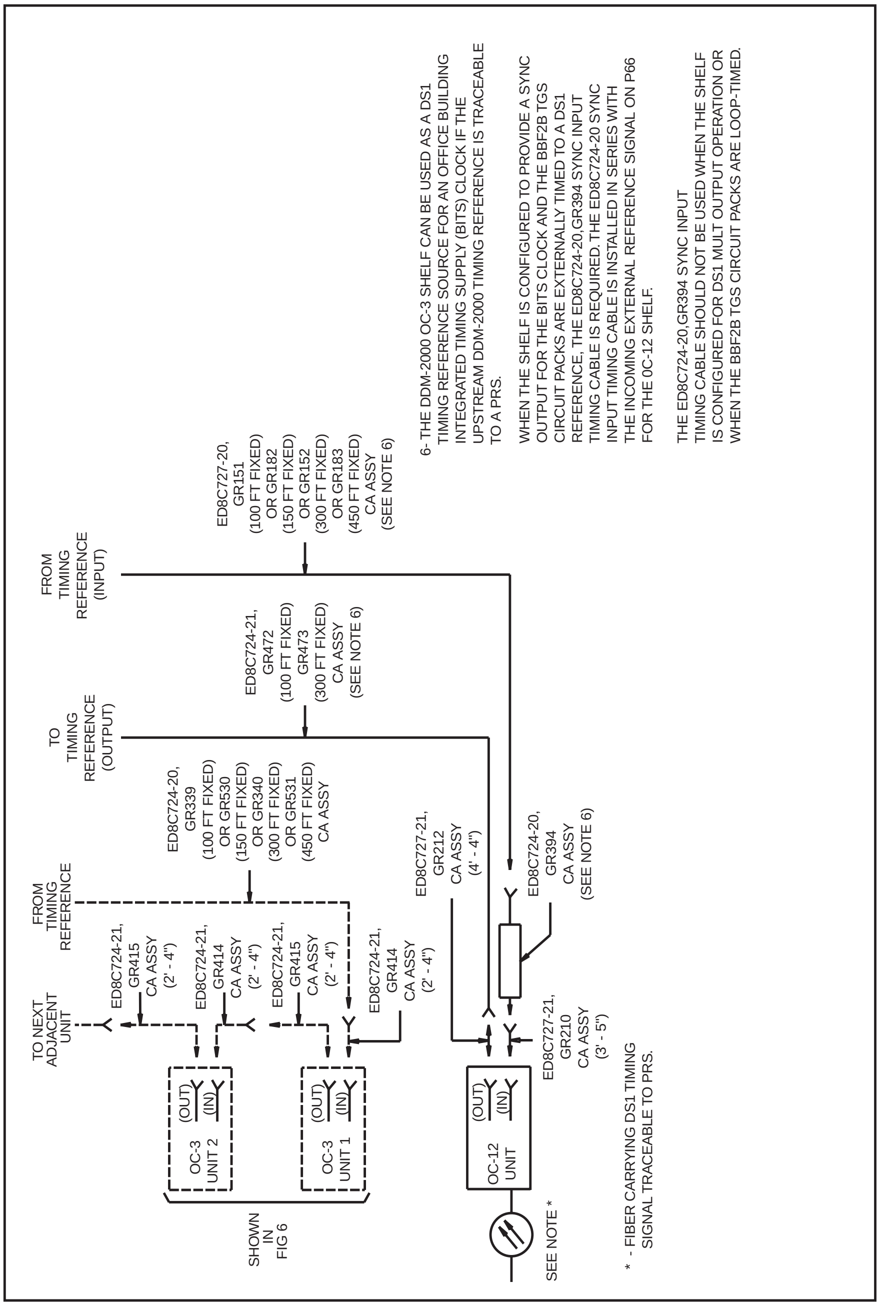


Figure 7-4-9 Synchronization for Timing Distribution Cable in a Bay Arrangement

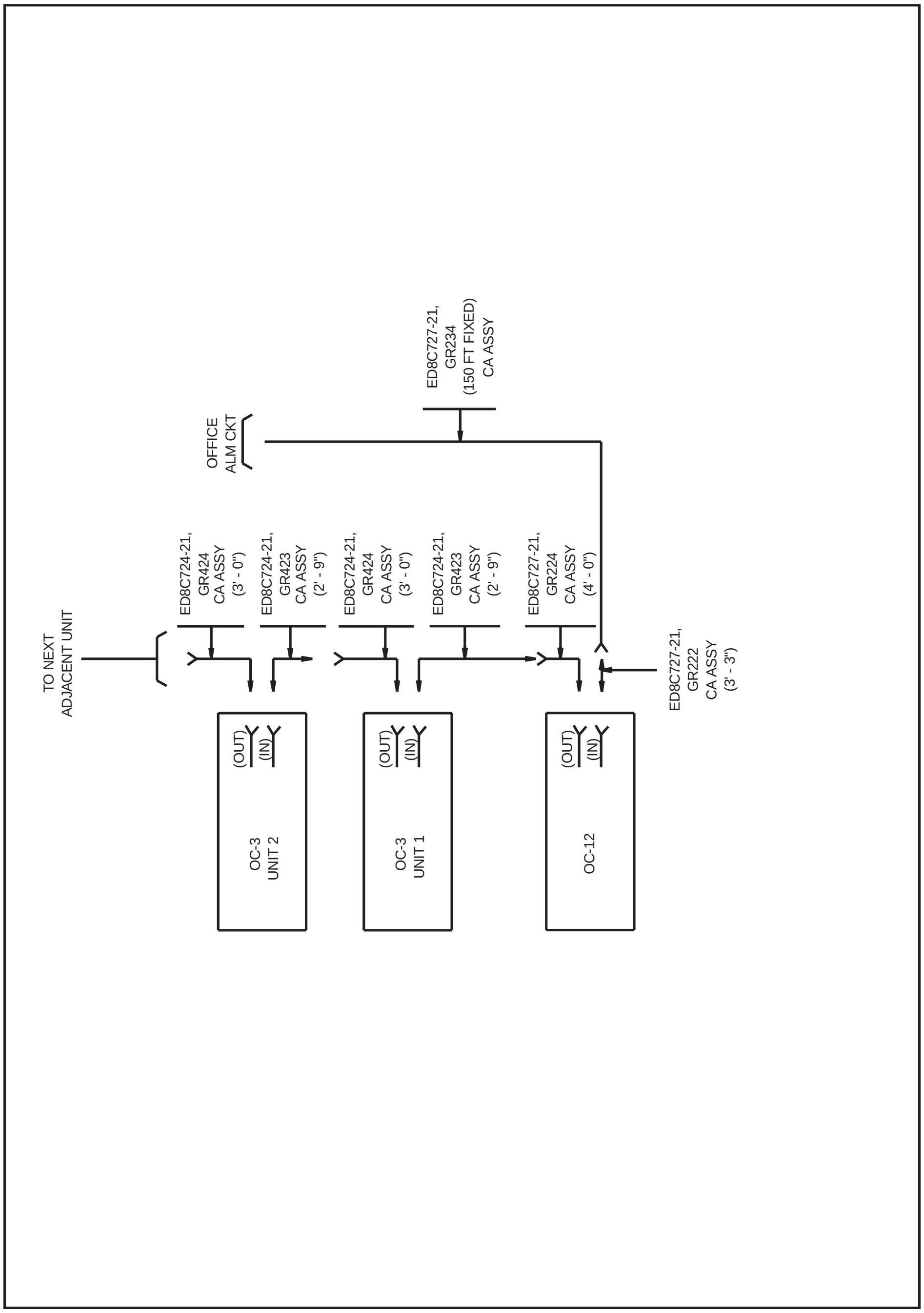


Figure 7-4-10 Office Alarm Interface and Mult Cable

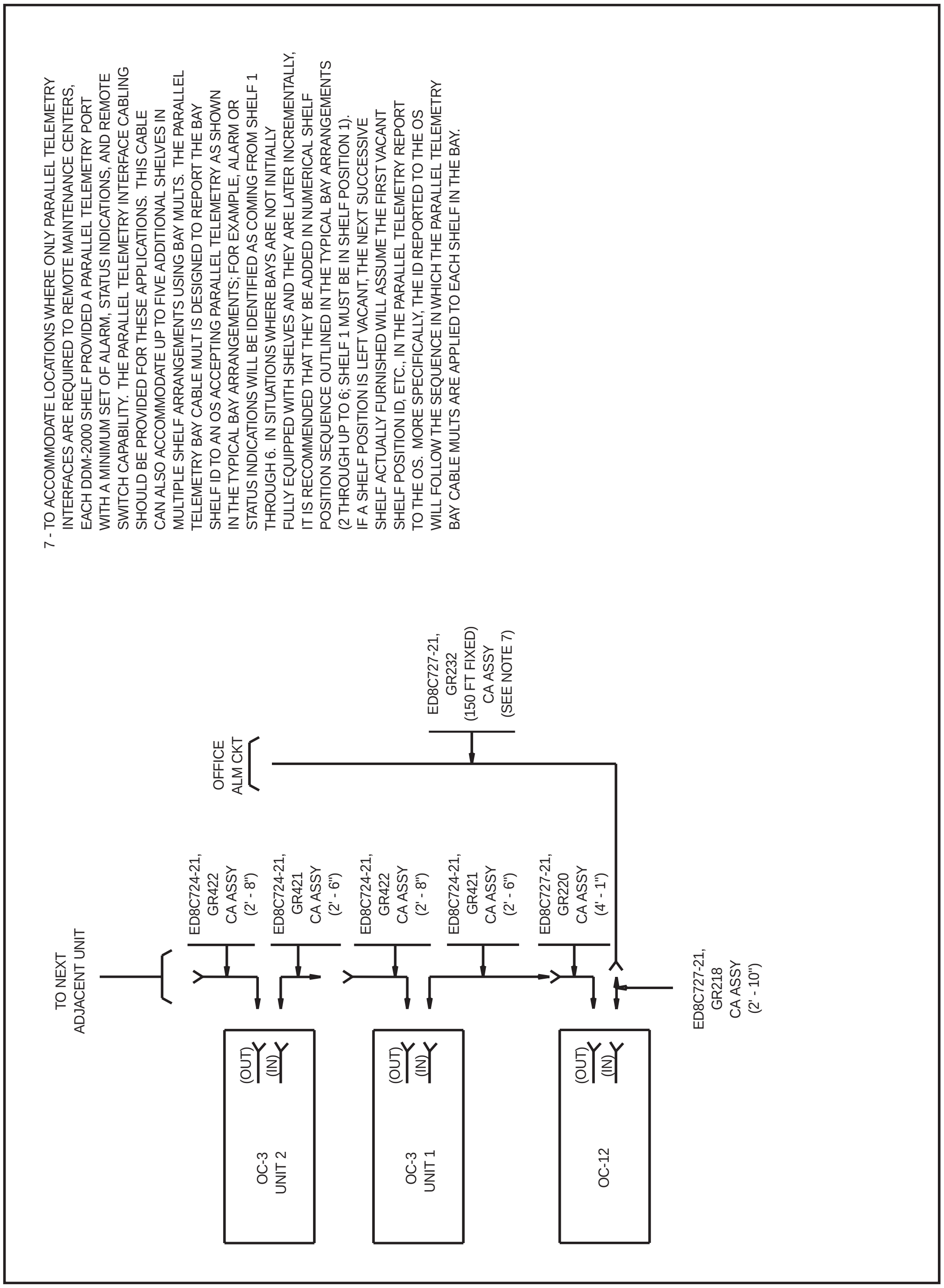


Figure 7-4-11 Parallel Telemetry Interface and Mult Cable

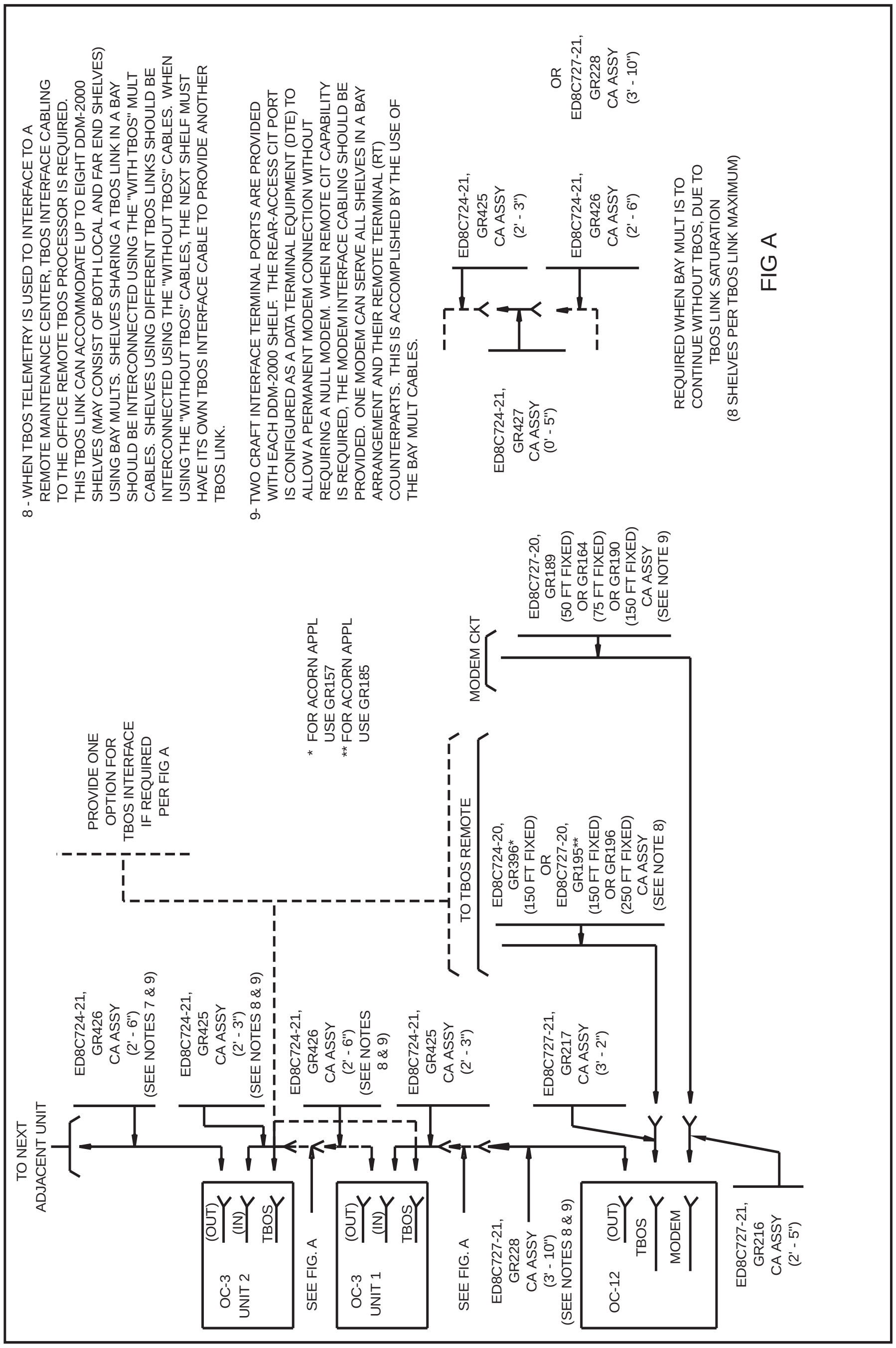


Figure 7-4-12 Modem, TBOS Interface, and Bay Mult Cable for TBOS, CIT, and Modem

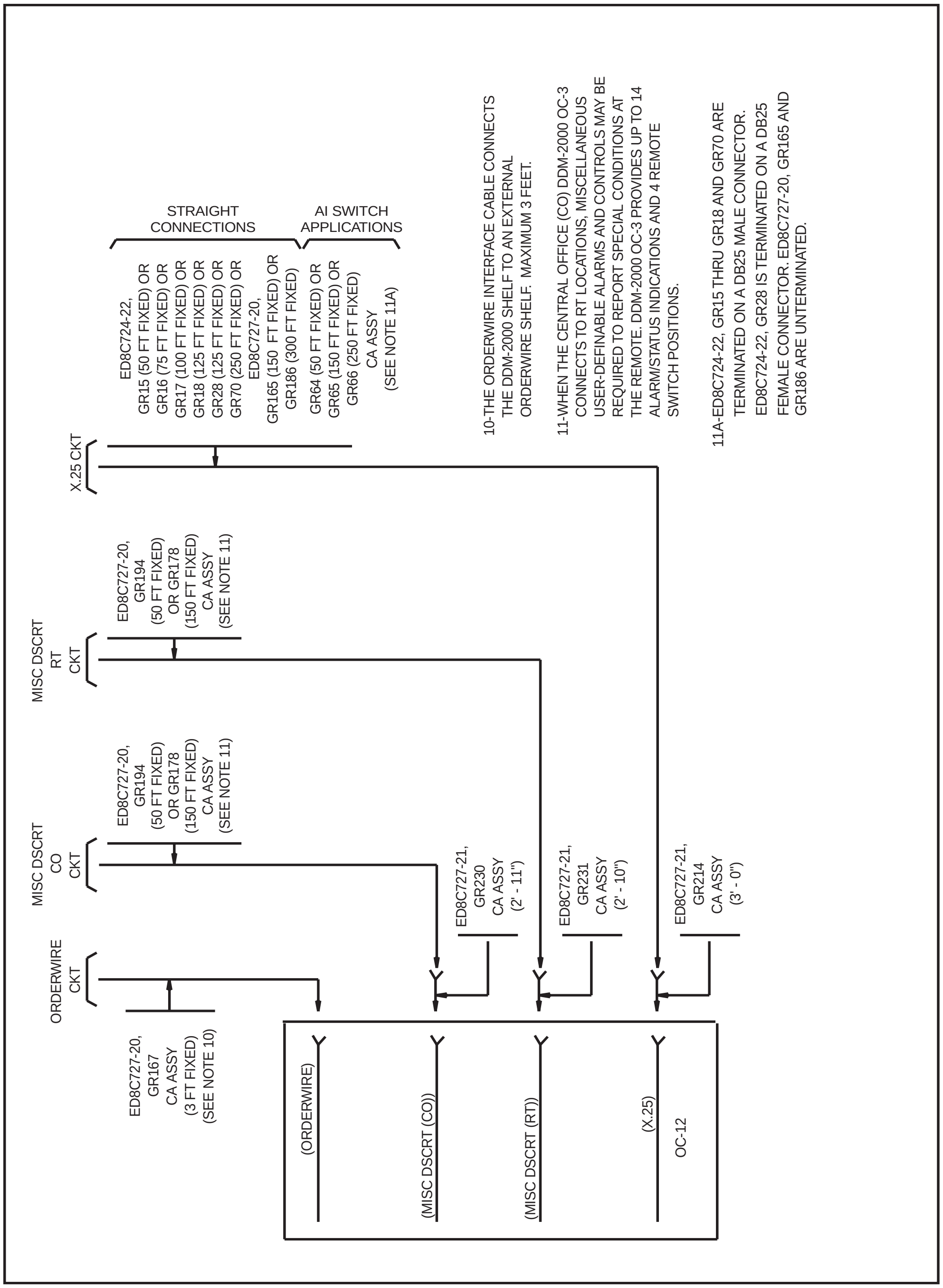
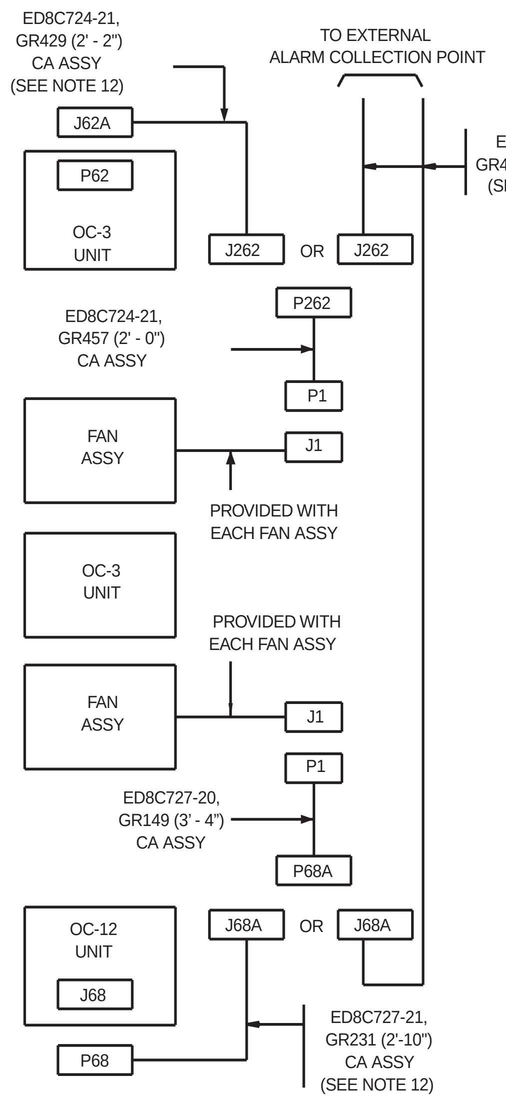


Figure 7-4-13 X.25 Interface, Miscellaneous Discretes, and Orderwire



12 - THIS CABLE IS THE PREFERRED METHOD FOR PROVIDING FAN ALARM INTERCONNECTION. ORDER THIS CABLE ASSEMBLY WHEN A CABLE HAS NOT BEEN ORDERED FOR MISC. DISCRETE (RT) APPLICATION PER FIG 7-4-14.

13 - ORDER THIS CABLE ASSEMBLY WHEN MISC. DISCRETE (RT) CABLE HAS BEEN ORDERED PER FIG 7-4-14. CONNECT FAN ALARMS TO MISC. DISCRETE INPUTS AT ALARM COLLECTION POINT AT REMOTE SITE.

FANS FOR THE OC-3 SHELF ARE ONLY REQUIRED IN CABINET APPLICATIONS AND IN UNCONTROLLED ENVIRONMENTS.

Figure 7-4-14 Cable Assembly for Fan Alarm

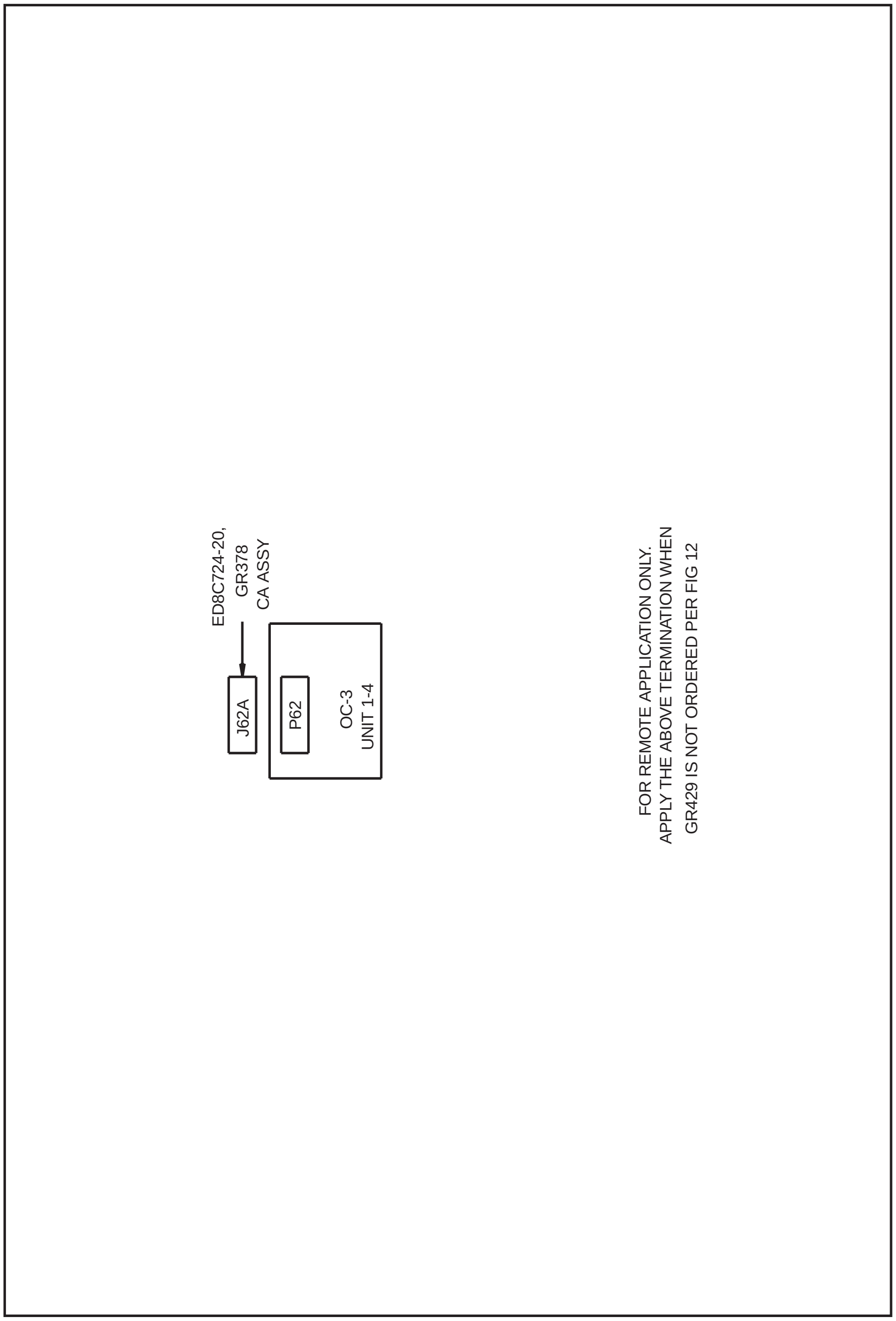


Figure 7-4-15 Fan Alarm Ground Assembly

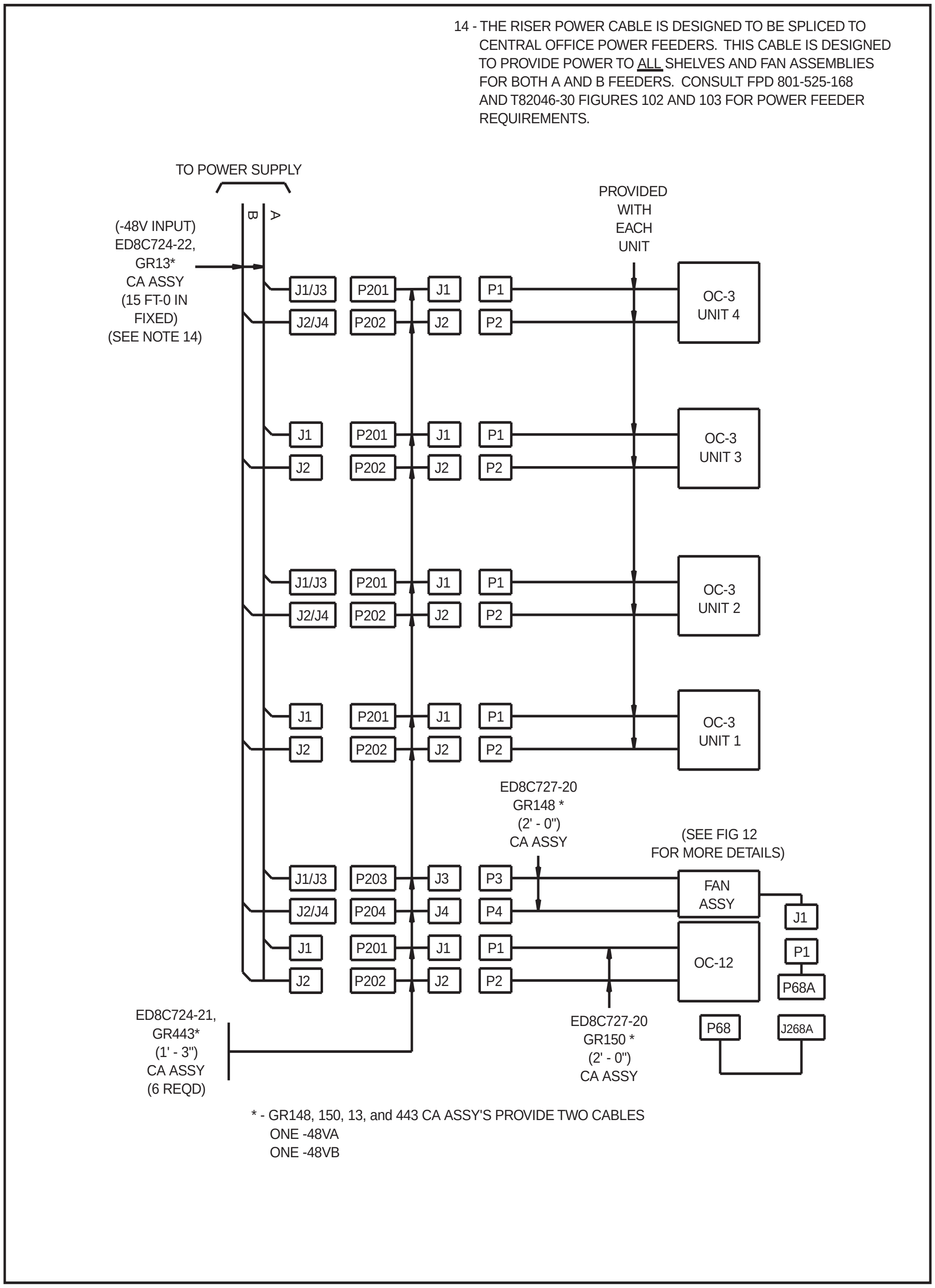


Figure 7-4-16 Power Input Cable for Bay Arrangement of OC-3/OC-12 Front Access

OC-3/OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 1 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
DS1 26-Gauge Wire Application, One Group Required per MULDEM	7-4-2	ED8C724-21	434 or	75		3		One Group per MULDEM Length ≥ 30 Feet
	7-4-2		435 or	100				
	7-4-2	846881621				12		MULDEMs A, B, and C Length ≤ 20 Feet
	7-4-2	ED8C724-21	450			1		MULDEM A
	7-4-2		451			1		MULDEM B
	7-4-2		452			1		MULDEM C
DS1 22-Gauge Wire Application, One Group Required per MULDEM	7-4-3	ED8C724-21	431 or	75		3		One Group per MULDEM Length ≥ 30 Feet
	7-4-3		432 or	150				
	7-4-3		466	300				
	7-4-3		467	400				
	7-4-3		450			1		MULDEM A
	7-4-3		451			1		MULDEM B
	7-4-3		452			1		MULDEM C

OC-3/OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 2 OF 8)

Fig. Description	Fig.	Code	Group/ Comcode Num	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
735A Cable for DS3/EC-1 Applications When Wiring Each MULDEM on an Individual Basis (OC-12 Shelf)	7-4-4/ 7-4-5	ED8C900-12	108799511* (Table 1U)	150	24			Note 1 Six Groups (cables) Required per MULDEM
	7-4-4/ 7-4-5	ED8C727-21	201		1			MULDEM A
	7-4-4/ 7-4-5		202		1			MULDEM B
	7-4-4/ 7-4-5		203		1			MULDEM C
	7-4-4/ 7-4-5		204		1			MULDEM D
735A Cable for DS3/EC-1 Applications When Wiring Each MULDEM on an Individual Basis (OC-3 Shelf)	7-4-6/ 7-4-7	ED-8C900-12	108799511* (Table 1U)	150		6		Note 1 Two Groups (cables) Required per MULDEM
	7-4-6/ 7-4-7	ED-8C724-21	453			1		MULDEM A
	7-4-6/ 7-4-7		454			1		MULDEM B
	7-4-6/ 7-4-7		455			1		MULDEM C
	7-4-6/ 7-4-7		413					One Group 413 May Be Used in Place of Groups 453 to 455
735A Cable for DS3 Interface with BBG19	7-4-6/ 7-4-7	ED8C724-22	37 or	150	1	1		One Group Required per MULDEM
	7-4-6/ 7-4-7		74	50				

* Straight BNC — loose straight BNC.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

OC-3/OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 3 OF 8)

Fig. Description	Fig.	Code	Group/Comcode Num	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
1735006A Cable for DS3/EC-1 Applications When all Three MULDEMs are Wired at the Same Time (OC-12 Shelf)	7-4-4/ 7-4-5	ED8C900-12	108811548* (Table 4U)	150	4			Note 1 One Group Required per MULDEM
	7-4-4/ 7-4-5	ED8C727-21	201		1			MULDEM A
	7-4-4/ 7-4-5		202		1			MULDEM B
	7-4-4/ 7-4-5		203		1			MULDEM C
	7-4-4/ 7-4-5		204		1			MULDEM D
734D Cable for DS3/EC-1 Applications When Cable Length Exceeds the 735 Type Cable Requirements (OC-12 Shelf)	7-4-4/ 7-4-5	ED8C900-12	108817800** (Table 6G)	300	24			Notes 1 and 2 Six Groups (cables) Required per MULDEM
	7-4-4/ 7-4-5	ED8C727-21	201		1			MULDEM A
	7-4-4/ 7-4-5		202		1			MULDEM B
	7-4-4/ 7-4-5		203		1			MULDEM C
	7-4-4/ 7-4-5		204		1			MULDEM D

* Straight BNC — loose straight BNC.
** Straight BNC — no connector.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

Note 2: One end has no connector. Order with comcode 407772235 for straight BNC. See Table 7A from ED-8C900-12 for other connector types.

OC-3/OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 4 OF 8)

Fig. Description	Fig.	Code	Group/Comcode Num	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
734D Cable for DS3/EC-1 Applications When Cable Length Exceeds the 735 Type Cable Requirements (OC-3 Shelf)	7-4-6/ 7-4-7	ED8C900-12	108817800*	300		6		Notes 1 and 2 Two Groups (cables) Required Per MULDEM
	7-4-6/ 7-4-7	ED8C724-21	453			1		MULDEM A
	7-4-6/ 7-4-7		454			1		MULDEM B
	7-4-6/ 7-4-7		455			1		MULDEM C
	7-4-6/ 7-4-7		413			See Note		One Group 413 May Be Used in Place of Groups 453 to 455

* Straight BNC — no connector.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

Note 2: One end has no connector. Order with comcode 407772235 for straight BNC. See Table 7A from ED-8C900-12 for other connector types.

OC-3/OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 5 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
DS1 Timing Input and MULT Cable Required Between Adjacent Units	7-4-8	ED8C727-20	151 or	100	1			
	7-4-8		152 or	300				
	7-4-8		182 or	150				
	7-4-8		183	450				
	7-4-8	ED8C724-21	414			1		
	7-4-8		415			1		
	7-4-8	ED8C727-21	210		1			
	7-4-8		212		1			
Synchronization for Timing Distribution Cable in a Bay Arrangement	7-4-9	ED8C727-20	151 or	100	1			
	7-4-9		152 or	300				
	7-4-9		182 or	150				
			183	450				
	7-4-9	ED8C724-20	394		1			
	7-4-9	ED8C724-21	414			1		As Required Per Fig. 7-4-8
	7-4-9		415			1		As Required Per Fig. 7-4-8
	7-4-9		472	100	1			
	7-4-9		473	300	1			
	7-4-9	ED8C727-21	210		1			
	7-4-9		212		1			
	7-4-9	ED8C724-20	339 or	100		See Note		As Required Per Fig. 7-4-8
	7-4-9		340 or	300				
	7-4-9		530 or	150				
	7-4-9		531	450				

OC-3/OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 6 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes	
Office Alarm Interface and MULT Cable Required Between Adjacent Units	7-4-10	ED8C727-21	234 or	150	1				
	7-4-10		222		1				
	7-4-10		224		1				
	7-4-10	ED8C724-21	423			1			
	7-4-10		424			1			
Parallel Telemetry Interface and MULT Cable Required Between Adjacent Units	7-4-11	ED8C727-21	232 or	150	1				
	7-4-11	ED8C724-21	421			1			
	7-4-11		422			1			
	7-4-11	ED8C727-21	218		1				
	7-4-11		220		1				
Modem, TBOS Interface and MULT Cable for TBOS and Bay MULT Wiring Between Adjacent Units	7-4-12	ED8C727-20	164 or	75	1			MODEM	
	7-4-12		189 or	50					
	7-4-12		190	150					
	7-4-12		157 or	150	1	A/R		TBOS	For (AT&T) ACORN Applications
	7-4-12		185 or	300					
	7-4-12	ED8C724-20	396 or	150					For OC-3 Non-ACORN Applications
	7-4-12	ED8C727-20	195 or	150					For OC-12 Non-ACORN Applications
	7-4-12		196	250					
	7-4-12	ED8C724-21	427		1	1			Only Required Per Fig. A
	7-4-12	ED8C727-21	216		1				Modem
	7-4-12		217		1	A/R			TBOS
	7-4-12		228		1				
	7-4-12	ED8C724-21	426			1			
	7-4-12		425			1			

OC-3/OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 7 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes	
X.25 Interface, Miscellaneous Discretes, and Orderwire Cables as Required for each OC-12 Unit	7-4-13	ED8C727-20	165 or	150	1	1		X.25	Unterminated
	7-4-13		186 or	300					
	7-4-13	ED8C724-22	15 or	50					Terminated on Male Connector
	7-4-13		16 or	75					
	7-4-13		17 or	100					
	7-4-13		18 or	125					
	7-4-13		70 or	250					
	7-4-13		28	125					Term. on Female Conn.
	7-4-13		64	50					AI Switch
	7-4-13		65	150					
	7-4-13		66	250					
	7-4-13	ED8C727-20	167		1	1		Orderwire	
	7-4-13		178 or	150	1 or 2	1 or 2		Miscellaneous Discrete 1 — Points 1-15 1 — Inputs 16-21 (RT Only)	
	7-4-13		194	50					
	7-4-13	ED8C727-21	214		1	1		X.25	
	7-4-13		231 or		1	1		Miscellaneous Discrete	
	7-4-13		230						

OC-3/OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 8 OF 8)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
Cable Assembly for Fan Alarm	7-4-14	ED8C727-20	149		1			
	7-4-14	ED8C727-21	231 or		1			
	7-4-14	ED8C724-21	460	150				
	7-4-14		457			1		One Per OC-3 Fan Assembly
	7-4-14		429 or			1		One Per OC-3 Fan Assembly
	7-4-14		460	150				
For Remote Applications Only, Apply This Termination When GR429 is not Ordered Per Fig. 7-4-15	7-4-15	ED8C724-20	378			A/R		See Fig. 7-4-15
Power Input Cable for Bay Arrangement of OC-3/OC-12 Front Access Units	7-4-16	ED8C724-22	13		1			Power Riser
	7-4-16	ED8C724-21	443		A/R	A/R		One Per Each Additional Unit or Fan Assembly-Power Cable
	7-4-16	ED8C727-20	148		1			Fan Power (OC-12)
	7-4-16		150		1			Shelf Power (OC-12)

Software Ordering

DDM-2000 OC-3 Software Ording

Table 7-2 lists comcode numbers for the ordering of DDM-2000 OC-3 software:

Table 7-2. OC-3 Software Ording

Equipment Code Group/List Code	Description
109023671	Release 7.2.5 Initial Application (floppy)
109023689	Release 7.2.5 Upgrade Application "from releases 3, 5, 6, 7, CN application"
109023697	Release 7.2.5 Spare Software
108583576	Release 8.1.2 Initial Application (floppy)
109023705	Release 8.1.2 Upgrade Application "from releases 3, 6, 8, CN application"
109023713	Release 8.1.2 Spare Software
109023721	Release 9.1.1 Initial Application (floppy)
109023648	Release 9.1.1 Upgrade Application "from releases 3, 5, 6, 7, 8, 9, CN application"
109023655	Release 9.1.1 Spare Software
108621269	Release 11.0.4 Software Kit Application
108583584	Release 11.1.3 Initial Application (floppy)
109023663	Release 11.1.3 Upgrade Application "from releases 3, 5, 6, 7, 8, 9, 11, CN application"
109023531	Release 11.1.3 Spare Software
109023747	Release 11.1.3 Initial Application (datape)
109023754	Release 11.1.3 Upgrade Application "from releases 3, 5, 6, 7, 8, 9, 11, CN application"
109023762	Release 11.1.3 Spare Software
109160689	Release 13.0.4 Initial Application (floppy)
109160697	Release 13.0.4 Initial Application (CDROM)
109160705	Release 13.0.4 Upgrade Application (floppy)
109160713	Release 13.0.4 Upgrade Application (CDROM)
109160721	Release 13.0.4 Spare Software (floppy)
109160739	Release 13.0.4 Spare Software (CDROM)

Table 7-2. OC-3 Software Ording —*Continued*

Equipment Code Group/List Code	Description
108988213	Release 13.5.3 Initial Application
108988221	Release 13.5.3 Upgrade Application from CN application
108988239	Release 13.5.3 Spare Software
109106690	Release 15.0.4 Initial Application (floppy)
109106732	Release 15.0.4 Initial Application (CDROM)
109106716	Release 15.0.4 Upgrade Kit (floppy)
109106740	Release 15.0.4 Upgrade Kit (CDROM)
109106724	Release 15.0.4 Spare Software (floppy)
109106757	Release 15.0.4 Spare Software (CDROM)
109150847	Release 15.1.2 Initial Application (floppy)
109150854	Release 15.1.2 Initial Application (CDROM)

Keep the following in mind before placing your order:

- DDM-2000 OC-3 software comes separately from the hardware.
- **Order one set of software for each shelf**. Software orders must be placed in addition to the hardware order to receive software and to properly maintain office records.
- All system controller (SYSCTL) circuit packs are shipped without software loaded on them. Therefore, software loading must occur at or before installation. This is achieved by downloading software furnished on floppy diskettes (which ship separately from the SYSCTL), using an *MS-DOS*[*] PC. With OC-3 R13.0, R15.0, and OC-12 R7.0, software may also be downloaded from ITM SNC via the IAO LAN interface.
- It may be desirable to have backup diskettes for all releases on hand for backup or initial downloading.
- All network elements (NEs) in a ring or linear network, which may be part of a larger network, must be running the same software. For example, in a Release 7 OC-3 ring, you can't have some nodes running 7.0.n while others are running 7.1.n. In a maintenance subnetwork, which may consist of a mixture of ring and linear networks, all NEs must be running compatible software. The only exception to this general rule is that the mixing of Release 7.2.x and Releases 8.0.x, 8.1.x, 9.0.x, 9.1.x, or 11.0.x is allowed for certain applications. There are some restrictions such as network size when these releases are mixed. See Software Upgrades in Section 5, "OAM&P," for a table listing software compatibility.

* Registered trademark of Microsoft Corporation.

- Features are included when the software is ordered by comcode.
- A user/service manual is **not** shipped with each shelf unless specified on the shelf order. Manuals can be ordered using the software ordering blank.

The software ordering table includes a cross-reference to common language element identifier (*CLEI* *) codes where available.

* COMMON LANGUAGE is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Bell Communications Research, Inc.

Table 7-3 lists DDM-2000 OC-3 software that is no longer available.

Table 7-3. DDM-2000 OC-3 Discontinued Available (DA) Software

Product	Release	Drawing & Group(s)
OC-3	1.0/2.0	ED8C724-33, ALL
OC-3	2.1/3.1/3.2	ED8C724-34, ALL
OC-3	5.0/5.1	ED8C724-36, ALL
OC-3	6.X	ED8C724-37, ALL
OC-3	7.X	ED8C724-38, ALL
OC-3	8.X	ED8C724-39, ALL
OC-3	9.X	ED8C724-40, ALL
OC-3	11.0	ED8C724-41, ALL
OC-3	13.X	ED8C724-42, ALL
OC-3	15.X	ED8C724-43, ALL

All OC-3 software is no longer orderable by ED number. Please refer to Table 7-2, Page 7-117, for codes and releases that are available. Later point releases for Releases 7, 8, 9, 11, 13, and 15 are available by comcode.

Table 7-4 lists the applications that are supported by a particular software release:

Table 7-4. DDM-2000 OC-3 Multiplexer Application Summary Matrix

Application	Linear	Ring			
	R8.1	R7.2	R11.1	R13	R15
OC-3 Point-to-Point	X				
OC-3 Hub	X				
OC-3 STS-1 Drop	X				
OC-3 Repeater (21-type OLIU)	X				
OC-3 DS1/DS3 Linear A/D	X				
OC-3 Hub w/Grooming	X				
OC-3 Repeater (22-type OLIUs)	X				
SONET (EC-1) Electrical Mux.	X				
OC-3 with EC-1 low-speed	X				
DS1 Performance Monitoring	X	X	X	X	X
OC-3 DS1/DS3/EC-1 Ring		X	X	X	X
EC-1 DRI w/VT1.5/STS-1 Drop and continue		X	X	X	X
OC-3c Transport	X				
OC-3 Ring w/OC-3 Opt. Ext.		X	X	X	X
Linear Ext. from OC-3 Ring	X				
OC-3/OC-12 Ring with 0x1		X	X	X	X
DDM-2000 FiberReach Host			X	X	X
Mixed Controller Ntwks.		X			
OC-3 DRI w/VT1.5/STS-1 Drop and continue		X	X	X	X
Linear Ext. from OC-12 Ring	X				
VT Hairpin			X	X	X
DS1 Locked cross-connections			X	X	X
DS3 Locked cross-connections			X	X	X
OC-12 Interfaces from OC-3 Ring			X	X	X
MegaStar 2000 Radio	X		X		
Multivendor Operations Interworking				X	X
FiberReach Hairpin Topologies			X	X	X
Broadband Data Services			X	X	X
Transmultiplexer			X	X	X
HDSL Interface	X	X	X	X	X
T1 Extension					X
LAN Interface					X

CPRO-2000 Software Ordering

Table 7-5 lists comcode numbers for the ordering of CPRO-2000 software:

Table 7-5. CPRO-2000 Software Ordering

Comcode	Description	Platform
109069765	CPRO-2000, Release 6.2, Initial Application Kit, which includes: (7) Floppy diskettes programmed with software and (1) Software Release Description	Non-TARP
109069773	CPRO-2000, Release 6.2, Upgrade Application Kit, which includes: (7) Floppy diskettes programmed with software and (1) Software Release Description	Non-TARP
109036426	CPRO-2000, Release 11.1, Initial Application Kit, which includes: (7) Floppy diskettes programmed with software and (1) Software Release Description	TARP
109036434	CPRO-2000, Release 11.1, Upgrade Application Kit, which includes: (7) Floppy diskettes programmed with software and (1) Software Release Description	TARP
109036442	CPRO-2000, Release 11.1, Initial Application Kit, which includes: (1) CDRom programmed with software and (1) Software Release Description	TARP
109036459	CPRO-2000, Release 11.1, Upgrade Application Kit, which includes: (1) CDRom programmed with software and (1) Software Release Description	TARP

Table 7-6. Software Compatibility for DDM-2000 OC-3

OC-3 Software Releases	OC-1 Software					OC-3 Software											OC-12 Software						OC-48 Software					
	2.1	2.2	3.0	3.1**	4.0**	6.2	7.1	7.2	8.0	8.1	9.0	9.1	11.0	11.1	13.0	15.0	2.3	3.1	5.0	5.1	5.2	7.0	6.0	7.0	7.1	7.2	9.0	9.1
OC-3, R6.2	NC	NC	NC	NC	NC	C	C	NC	NC	NC	NC	NC	NC	NC	NC	NC	C	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
OC-3, R7.1	NC	NC	NC	NC	NC	C	C	NC	NC	NC	NC	NC	NC	NC	NC	NC	C	C	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
OC-3, R7.2	C*	C	NC	NC	NC	NC	NC	C	C	C	C	C	C	C	NC	NC	NC	NC	C	C	C	NC	C	C	C	C	NC	NC
OC-3, R8.0	C*	C*	NC	NC	NC	NC	NC	C	C	NT	C	C	C	C	NC	NC	NC	NC	C	C	C	NC	C	C	C	C	NC	NC
OC-3, R8.1	C*	C*	NC	NC	NC	NC	NC	C	NT	C	C	C	C	C	NC	NC	NC	NC	C	C	C	NC	NT	C	C	C	NC	NC
OC-3, R9.0	C	NT	NC	NC	NC	NC	NC	C	C	C	C	NT	NT	NT	NC	NC	NC	NC	C	NT	NT	NC	C	C	NT	NT	NC	NC
OC-3, R9.1	C	C	NC	NC	NC	NC	NC	C	C	C	NT	C	NT	NT	NC	NC	NC	NC	C	C	C	NC	NT	C	C	C	NC	NC
OC-3, R11.0	C	C	NC	NC	NC	NC	NC	C	C	C	NT	NT	C	NT	NC	NC	NC	NC	NT	C	C	NC	NT	NT	C	C	NC	NC
OC-3, R11.1	C	C	NC	NC	NC	NC	NC	C	C	C	NT	NT	NT	C	NC	NC	NC	NC	NT	C	C	NC	NT	NT	C	C	NC	NC
OC-3, R13.0	NC	NC	C	C	C	NC	NC	NC	NC	NC	NC	NC	NC	NC	C	C	NC	NC	NC	NC	NC	C	NC	NC	NC	NC	C	C
OC-3, R15.0	NC	NC	C	C	C	NC	NC	NC	NC	NC	NC	NC	NC	NC	C	C	NC	NC	NC	NC	NC	C	NC	NC	NC	NC	C	C

C - DCC Compatible Releases
C* - Compatible if included in the same subnetwork but shelves can not be physically interconnected
NT - Not Tested
NC - Not Compatible
** - Assumes FiberReach has OC-3 optics

OC-3 Plug-In Ordering

This section provides typical application figures and associated plug-in tables, order blanks for individual plug-in orders (Table 7-12 and Table 7-14), and sparing recommendations based on reliability projections for each plug-in unit. Before describing the plug-in ordering, a brief description of the shelf layout with required and optional plug-ins is in order. Refer to Figure 7-1.

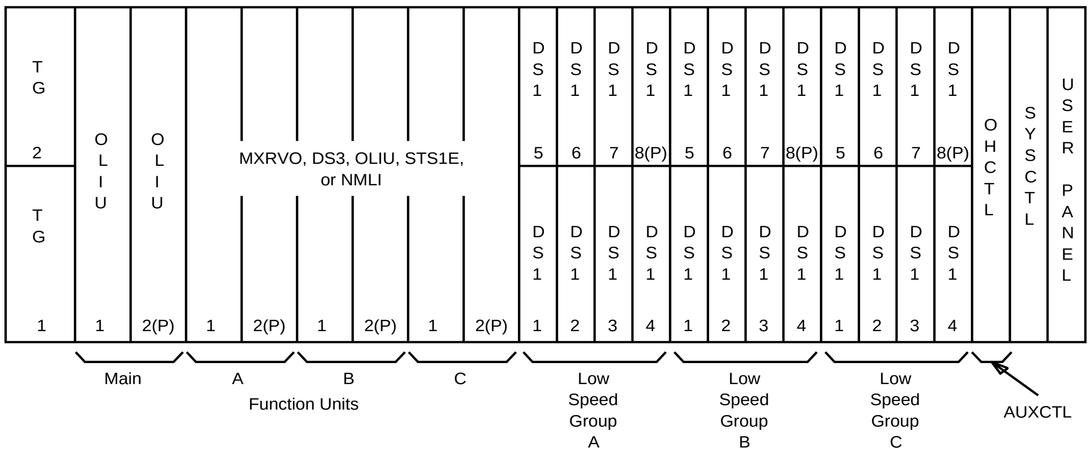


Figure 7-1. DDM-2000 OC-3 Shelf

From left to right, the TGS/TG3 plug-in is always required, although protection units are optional. This circuit pack supports the full range of synchronization needs for the DDM-2000 OC-3 and OC-12 Multiplexers in the external timing, loop timing, and free running modes and also supports a DS1 timing output feature. The OLIU plug-in in the MAIN slot is also always required (except in electrical multiplexer applications), with optional protection units. Function unit slots, A, B, and C define how each of the three 28-DS1 groups will be administered; that is, if group A is to be broken down to 28 DS1s (or any incremental 4-DS1 groups of that 28), MXRVO plug-ins are furnished in positions 1 and 2 for group A (or only position 1 if protection is not desired), and low-speed group A slots may be equipped with DS1 plug-ins as needed, up to seven, for terminating a fully 28-DS1 circuit. Each DS1 plug-in terminates 4 DS1 circuits. The 8P DS1 plug-in is furnished if one-for-seven protection is desired.

If one group of 28 DS1s is to be terminated as a DS3 signal, all that is required is to furnish a DS3 plug-in in that particular function unit slot 1 and the associated

DS1 low-speed group slots are then unequipped. Again, if protection is desired, a DS3 unit will also be furnished in slot 2.

To the right of the DS1 low-speed plug-ins is the AUXCTL slot. An OHCTL unit must be placed in the AUXCTL slot at all locations.

At the right of the AUXCTL is the SYSCTL plug-in which provides the functions required for basic operation of the DDM-2000 OC-3 Multiplexer. One is required for each shelf.

To the right of the SYSCTL plug-in is the user panel. Although the user panel is manufactured as a separate equipment entity and is replaceable on an out-of-service basis, it is factory installed and ships as an integral part of the DDM-2000 OC-3 shelf.

Release 3 and later features allow additional plug-in configurations to activate hubbing and STS-1 linear drop applications. At an end location or at any location where DS1s or DS3s are to be dropped, plug-ins are configured as described above. At a hub location, an OLIU is required in each function unit slot from which a separate fiber route will terminate at a different location, beginning with the C function slot. For STS-1 linear drop, the C function slot is furnished with an OLIU to transmit the OC-3 signal along the linear fiber route. OLIUs are always required in the main slots. The TL-1 OS message-based feature comes as part of the controller hardware and software which is always furnished with Release 3 and later equipment.

Release 3 and later supports the 22F/22F-U/22F2-U OLIU, which provides full DS1 and DS3 add/drop capability; the 21D/21D-U OLIU, which provides a low-cost multimode optical interface between the OC-3 and OC-12 shelves; and the BBF2B TGS circuit pack, which provides DS1 timing outputs. The 22F/22F-U/22F2-U OLIU is used in the same manner as described above for the hubbing/linear OLIU placement, except that 22Fs must be used in the main slots if they are used in any of the function unit slots. The 21G/21G-U and 22F/22F-U/22F2-U OLIUs are compatible, however, at opposite ends of point-to-point systems. When invoking the add/drop feature, two criteria must be kept in mind: First, no more than 84 DS1s (or 3 DS3s) can go out on the optical line. Second, at an intermediate site where the shelf is looking two directions optically, any combination of 56 DS1s (or 2 DS3s) may be dropped and/or added since function unit C would be equipped with OLIUs. There may be cases where the number of DS1s added, dropped, and passed through would equal 112 (28 DS1s dropped, 28 DS1s added, and 56 DS1s passed through).

Release 7 is an enhanced ring release that requires the use of 22-type OLIUs in the main-1 and main-2 slots of all shelves in the ring. Release 7 features include: the BBG6 STS1E which provides a low-speed EC-1 interface and the BBF3 DS1PM which provides DS1 performance monitoring. The DS1PM can be mixed with the DS1 plug-ins in the Low-Speed Group slots. The STS1E plug-ins are

used in the function unit slots for EC-1 low-speed applications. Release 7 can drop DS1, DS3, and/or EC-1 low-speed signals from the ring.

Other Release 7 features include the 22D-U and the 22G-U OLIUs. The 22D-U OLIU provides a low-cost IS-3 with time slot interchange (TSI) optical interface between collocated OC-3 and OC-12 ring shelves. The 22G-U OLIU has the same functionality of the 22F/22F-U/22F2-U OLIU but with a 23 dB outside plant loss budget allowing for spans of up to 51 km. The "U" designation for the OLIUs means they have Universal Optical Connectors. These OLIUs have adapters that allow the use of *ST*, SC, or FC-PC connectors on the faceplates. The 22D-U and 22G-U OLIUs can be used in all 22F/22F-U/22F2-U OLIU applications starting with Release 3.1. Release 7 supports a "drop and continue" feature which is used with dual ring interworking (DRI) applications. Release 7 also supports 0x1 optical interconnects between DDM-2000 OC-3 and OC-12 ring shelves.

Release 7.2 is for mixed controller network ring applications. Release 7.2 supports operations interworking with the FT-2000 OC-48 Lightwave system and enhances the "drop and continue" feature to OC-3/IS-3 interfaces for dual ring interworking (DRI) applications. Release 7.2 also supports up to 24 network elements in a subnetwork, enhanced DS3 performance monitoring using the BBG4B DS3 circuit pack, and enhanced DS1 performance monitoring.

Release 6 for linear applications includes two plug-ins (and associated software): the BBG6 STS1E which provides both the high-speed and low-speed EC-1 interface and the BBF3 DS1PM which provides DS1 performance monitoring. The DS1PM can be mixed with the DS1 plug-ins in the Low-Speed Group slots. The STS1E plug-ins are used in the function unit slots for electrical multiplexer applications and low-speed applications.

Release 8 is for linear applications and includes three plug-ins and associated software: the BBG8 SYSCTL, BBG9 OHCTL, and the BBG4B DS3 circuit packs. The BBG8 SYSCTL and BBG9 OHCTL controller circuit packs are required for Release 8 and all higher releases. The BBG4B DS3 circuit pack replaces the BBG4 circuit pack but is only required if enhanced DS3 performance monitoring is needed. Release 8 supports operations interworking with the FT-2000 OC-48 Lightwave System. Release 8 also supports optical extensions from an OC-12 ring, up to 32 (24 to 32 with FT-2000 OC-48 Lightwave Systems) network elements in a subnetwork, and several OAM&P enhancements.

Release 8.1 is a linear release supporting all the circuit packs and applications of Release 8.0. Release 8.1 supports *MegaStar* 2000 SONET Radio. The BBG10 OHCTL overhead controller circuit pack is required in place of the BBG9 for all Release 8.1 *MegaStar* applications.

Release 9 is for ring applications and includes the same three plug-ins as described previously for Release 8 plus the 27G-U dual OC-1 OLIU and BBF5 jumper circuit packs. Release 9 supports operations interworking the FT-2000

OC-48 Lightwave System, can be a host shelf for the DDM-2000 FiberReach OC-1 extension or ring, enhances the "drop and continue" feature to OC-3/IS-3 interfaces for dual ring interworking (DRI) applications, and dual homing, VT hairpin, and locked cross-connection applications. Release 9 also supports up to 32 (24 to 32 with FT-2000 OC-48 Lightwave Systems) network elements in a subnetwork and several OAM&P enhancements.

Release 9.1 introduces the 27G2-U dual OC-1 OLIU, which is required for some FiberReach host extended topology configurations. Release 9.1 also increases network size to 50 network elements in a subnetwork.

Release 11.0 is an enhanced ring release which supports two circuit packs: A 24G-U OLIU is supported in the main slots and provides a standard OC-12 interface from the OC-3 shelf. A BBG19 DS3 interface circuit pack supports multi-media ATM-based data services. These services, such as Native Mode LAN Interface (NMLI), are provided via interconnections to commercially available data edge devices.

Release 11.1 introduces all transmission features of Release 13 (see following description) on the non-compliant OSI platform. This will allow these features to be deployed in mixed networks with older releases such as OC-3 R8.0 or R7.2, or FT-2000 Release 7. Transmission features and circuit packs include transmultiplexing with the BBG20 and HDSL interface via the BBF8 HDSL circuit pack. FiberReach host topologies are also expanded in Release 11.1 through the support of the 26G2-U OC-1 OLIU in the OC-3 shelf.

Release 13.0 is a ring release which brings DDM-2000 into compliance with Telcordia Technologies GR-253, supporting TARP, OSI compliant protocol stack. This release supports multivendor interworking at the transmission, as well as operations, level with vendors who support this protocol. Network partitioning through the implementation of Level 1 area provisioning and Level 2 routing allows DDM-2000 to be deployed in networks of up to 256 nodes within a single maintenance domain. IAO LAN to ITM SNC also simplifies operations and network management. Network deployment of Release 13 requires that all other NEs in the network be running compatible versions of software.

Release 13.0 transmission features and circuit packs include transmultiplexing with the BBG20 and HDSL interface via the BBF8 HDSL circuit pack. FiberReach host topologies are also expanded in Release 13 through the support of the 26G2-U OC-1 OLIU in the OC-3 shelf.

Release 15.0 is a ring release compliant with Telcordia Technologies GR-253, supporting TARP, OSI compliant protocol stack. This release supports multivendor interworking at the transmission, as well as operations, level with vendors who support this protocol. Network partitioning through the implementation of Level 1 area provisioning and Level 2 routing allows DDM-2000 to be deployed in networks of up to 256 nodes within a single maintenance domain. Each Level 1

area can be identified as a separate Alarm Group, as long as it does not exceed the 50 NE limit. Provisioning one alarm gateway NE (AGNE) is required in order to support remote office alarms and summary alarm information of remote NEs in the local alarm report. IAO LAN to ITM SNC also simplifies operations and network management. Network deployment of Release 15 requires that all other NEs in the network be running compatible versions of software.

Release 15.0 transmission features and circuit packs include low speed LAN interface with the BBF9 and BBF10 LAN and T1 carrier termination via the BBF6 T1EXT circuit pack. STS-3c and STS-1/VT1.5 0X1 configurations are also supported in Release 13 through the FUNCTION UNITS with 22-type OLIUs.

Typical Equipage Applications

The following figures and associated tables show some typical shelf applications for the DDM-2000 OC-3 Multiplexer:

- End Terminal Shelf Equipped With (E/W) 28 DS1, 1 DS3, and 1 EC-1 Circuits (Figure 7-2)
- End Terminal Shelf Equipped With 28 DS1 Performance Monitoring Circuits
(Figure 7-3)
- Hub Shelf Equipped With 28 DS1 Circuits and 2 OC-3 Optical Extensions (Figure 7-4)
- Add/Drop Shelf Equipped With 28 DS1 Circuits and 1 DS3 (Figure 7-5)
- OC-3 Repeater Shelf (Figure 7-6)
- Electrical SONET Shelf Equipped With 84 DS1 Circuits (Figure 7-7)
- Ring Shelf Equipped With 28 DS1 Circuits (Figure 7-8)
- Ring Shelf Equipped With 28 DS1, 1 DS3, and 1 EC-1 Circuits (Figure 7-9).
- Ring Shelf Equipped With 28 DS1, 1 DS3, and 1 OC-3 Optical Extension (Figure 7-10).
- Ring Shelf Equipped With 28 DS1 Circuits and 2 OC-1 Optical Extensions (DDM-2000 FiberReach Host) (Figure 7-11).
- MegaStar 2000 Interface Shelf Equipped With 28 DS1 Circuits, 1 DS3 (Figure 7-12)
- OC-3 Shelf with OC-12 Optics, Equipped With 28 DS1, 1 DS3, and 1 EC-1 Circuits (Figure 7-13)
- OC3/OC-12 Shelf Equipped With 3 DS3, 84 DS1, and 1 OC-3 Optical Extension (Figure 7-14).
- OC3/OC-12 Ring Shelf Equipped With 3 EC-1s and 84 DS1 (Figure 7-15).

- OC-3 Shelf with OC-12 Optics, Equipped With Data SVCS/NMLI Interface (Figure 7-16).
- OC-3/OC-12 Shelf with HDSL Interface (Figure 7-17).
- OC-3/OC-12 Shelf, Equipped With Transmultiplexer (Figure 7-18).
- OC-3 Shelf as FiberReach Host with 26G2-U OLIUs (Figure 7-19).
- OC-3/OC-12 Shelf with T1 Carrier Termination (Figure 7-20).
- OC-3/OC-12 Shelf with LAN Interface (Figure 7-21).

NOTE:
In the tables associated with each figure, the slash (/) separates the old shelf, old controllers and earlier software from the new shelf, new controllers and new software.

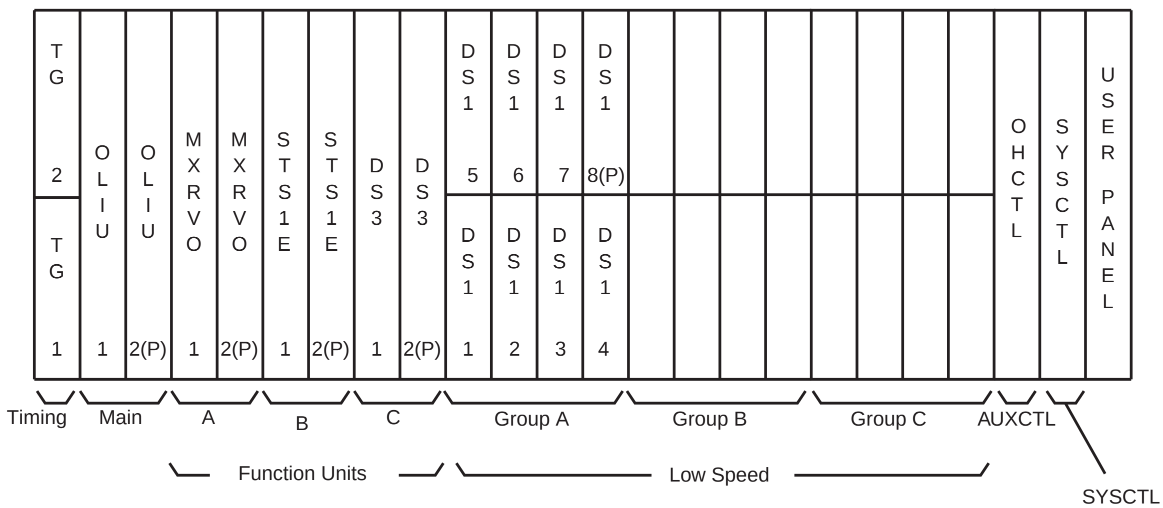


Figure 7-2. **End Terminal Shelf Equipped With 28 DS1, 1 DS3, and 1 EC-1 Circuits**

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, B/D ‡
2	TGS Timing Generator	BBF2B/BBF2C
2	OC-3 Optical Line Interface Unit	21- * or 22-type *
2	MXRVO Multiplexer CPs	BBG2B
2	STS1E EC-1 CPs	BBG6
2	DS3 CPs	BBG4B
8	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG7/BBG9
1	SYSCTL System Controller	BBG5/BBG8B
1	OC-3 Release 6/8 software †	

* 21-type allows STS-1 cross-connections; 22-type allows VT1.5/STS-1 cross-connections.

‡ Group B is for R7 and earlier, Group D is for R8.x, R9.x, and R11.x.

† Software must be ordered separately. See "Software Ordering" section.

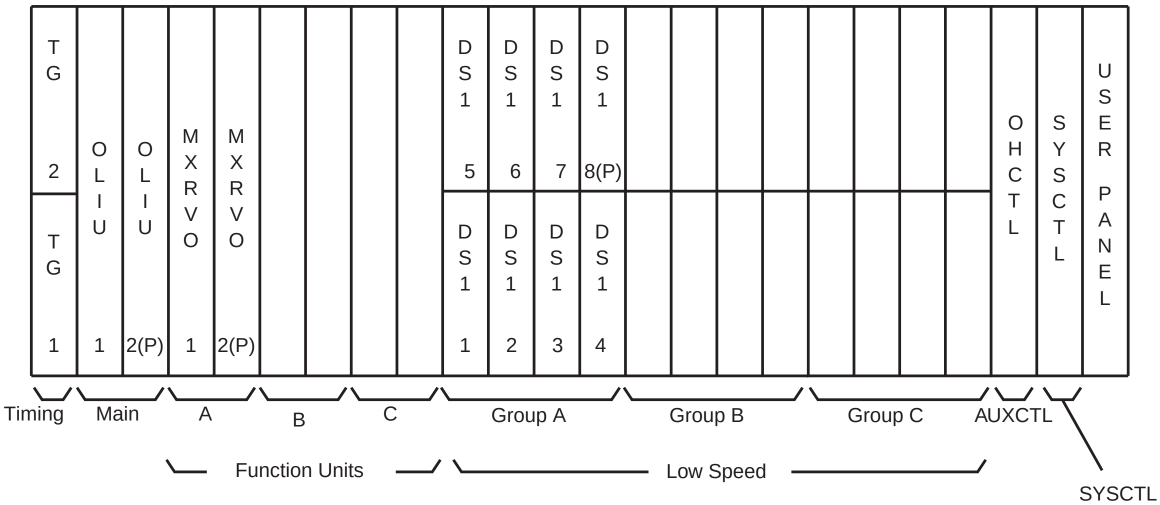


Figure 7-3. End Terminal Shelf Equipped With 28 DS1 Performance Monitoring Circuits

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, B/D ‡
2	TGS Timing Generator	BBF2B/BBF2C
2	OC-3 Optical Line Interface Unit	21- * or 22-type *
2	MXRVO Multiplexer CPs	BBG2B
8	DS1PM CPs	BBF3/BBF3B
1	OHCTL Overhead Controller	BBG7/BBG9
1	SYSCTL System Controller	BBG5/BBG8B
1	OC-3 Release 6/8 software †	

* 21-type allows STS-1 cross-connections; 22-type allows VT1.5/STS-1 cross-connections.

‡ Group B is for R7 and earlier, Group D is for R8.x, R9.x, and R11.x.

† Software must be ordered separately. See "Software Ordering" section.

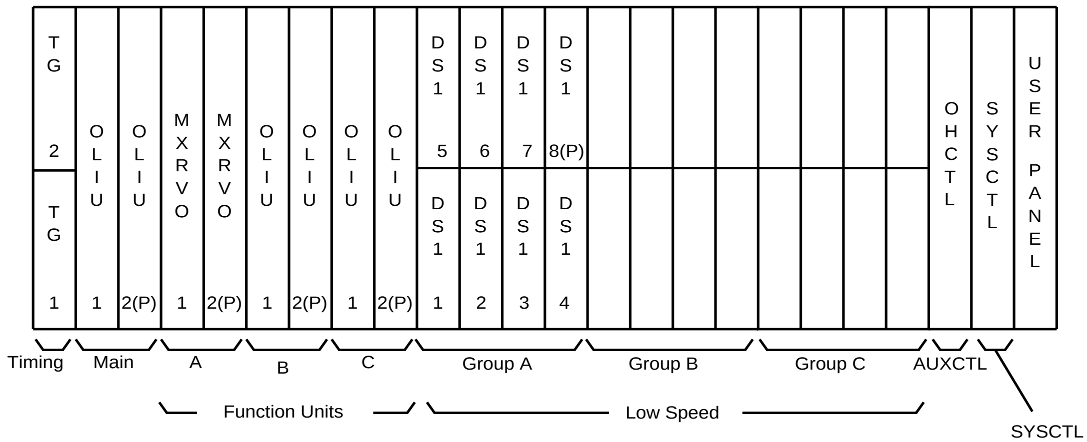


Figure 7-4. Hub Shelf Equipped With 28 DS1 Circuits and 2 OC-3 Optical Extensions

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, B/D ‡
2	TGS Timing Generator	BBF2B/BBF2C
6	OC-3 Optical Line Interface Unit	21- * or 22-type *
2	MXRVO Multiplexer CPs	BBG2B
8	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG7/BBG9
1	SYSCTL System Controller	BBG5/BBG8B
1	OC-3 R3, R6/R8 software †	

* 21-type allows STS-1 cross-connections; 22-type allows VT1.5/STS-1 cross-connections.

‡ Group B is for R7 and earlier, Group D is for R8.x, R9.x, and R11.x.

† Software must be ordered separately. See "Software Ordering" section.

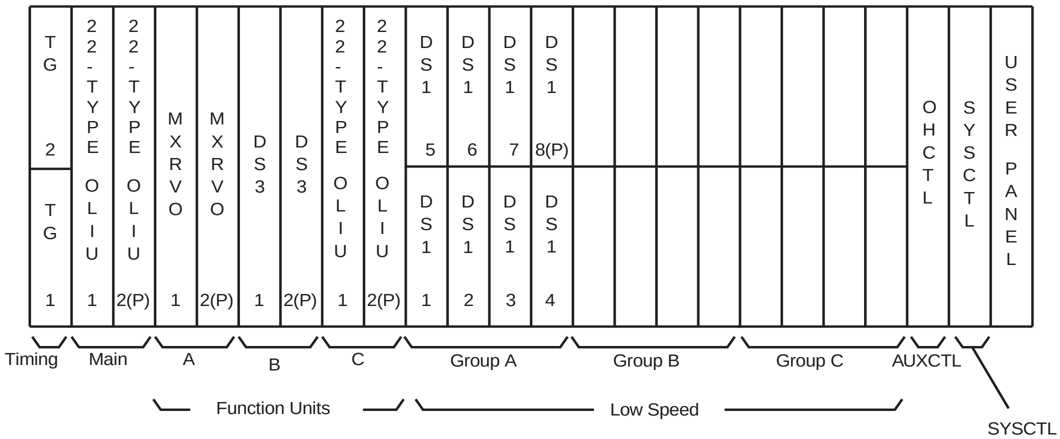


Figure 7-5. Add/Drop Shelf Equipped With 28 DS1 Circuits and 1 DS3

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, B/D ‡
2	TGS Timing Generator	BBF2B/BBF2C
4	OC-3 Optical Line Interface Unit w/TSI	22-type
2	MXRVO Multiplexer CPs	BBG2B
2	DS3 CPs	BBG4B
8	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG7/BBG9
1	SYSCTL System Controller	BBG5/BBG8B
1	OC-3 R3, R6/R8 software *	

* Software must be ordered separately. See "Software Ordering" section.

‡ Group B is for R7 and earlier, Group D is for R8.x, R9.x, and R11.x.

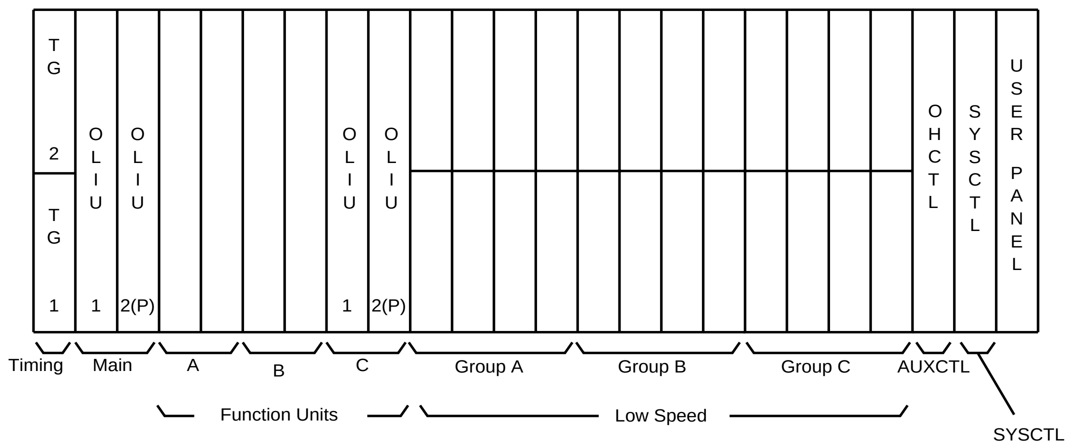


Figure 7-6. OC-3 Repeater Shelf

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, B/D ‡
2	TGS Timing Generator	BBF2B/BBF2C
4	OC-3 Optical Line Interface Unit	21- * or 22-type *
1	OHCTL Overhead Controller	BBG7/BBG9
1	SYSCTL System Controller	BBG5/BBG8B
1	OC-3 R3, R6/R8 software †	

* 21-type allows STS-1 cross-connections; 22-type allows VT1.5/STS-1 cross-connections.

‡ Group B is for R7 and earlier, Group D is for R8.x, R9.x, and R11.x.

† Software must be ordered separately. See "Software Ordering" section.

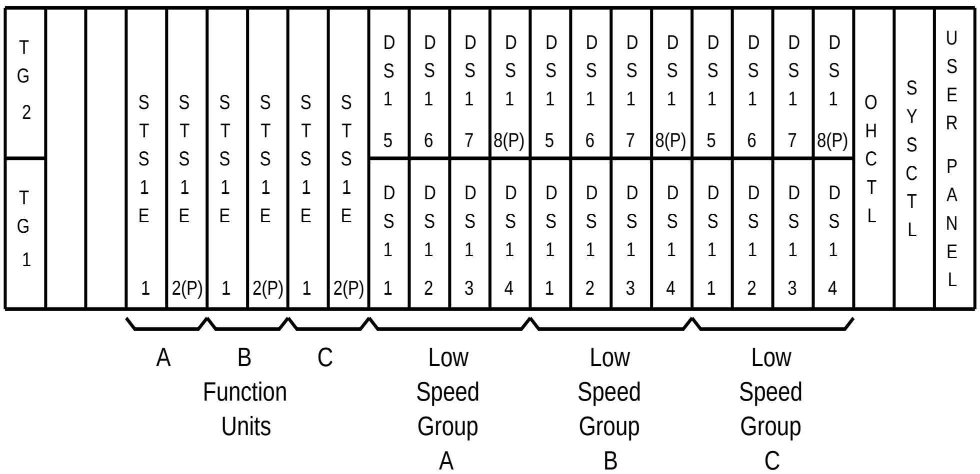


Figure 7-7. Electrical SONET Shelf Equipped With 84 DS1 Circuits

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, B/D ‡
2	TGS Timing Generator	BBF2B/BBF2C
6	STS1E EC-1 CPs	BBG6
24	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG7/BBG9
1	SYSCTL System Controller	BBG5/BBG8B
1	OC-3 R6/R8 software *	

* Software must be ordered separately. See "Software Ordering" section.

‡ Group B is for R7 and earlier, Group D is for R8.x, R9.x, and R11.x.

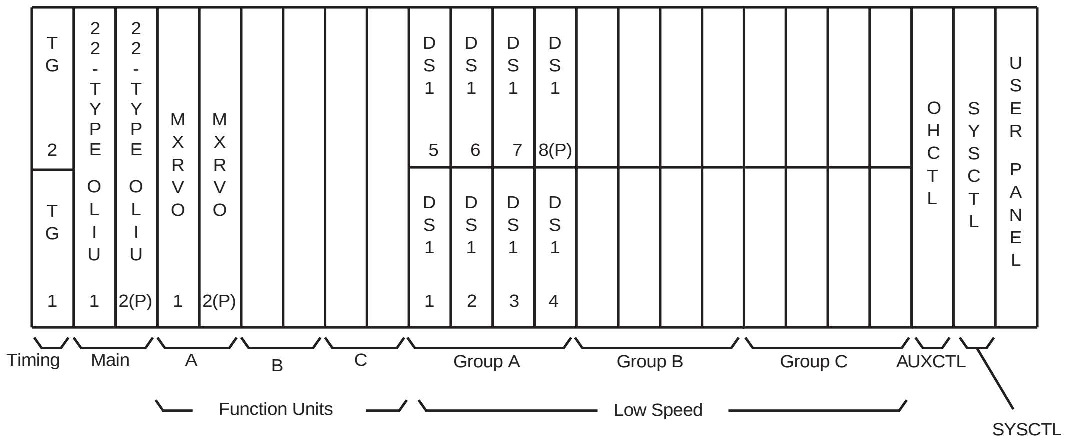


Figure 7-8. Ring Shelf Equipped With 28 DS1 Circuits

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, B/D/E ‡
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
2	OC-3 Optical Line Interface Unit w/TSI	22-type
2	MXRVO Multiplexer CPs	BBG2B
8	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG7/BBG9
1	SYSCTL System Controller	BBG5/BBG8B
1	OC-3 R5, R7/R9/R11/R13/R15 software *	

* Software must be ordered separately. See "Software Ordering" section.

‡ Group B is for R7 and earlier, Group D is for R8 and later, Group E for R13 and later.

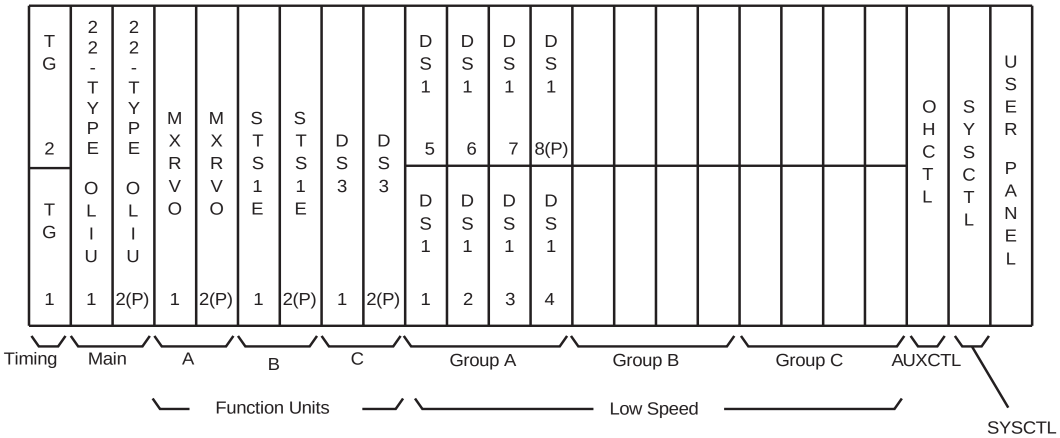


Figure 7-9. Ring Shelf Equipped With 28 DS1, 1 DS3, and 1 EC-1 Circuits

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, B/D/E ‡
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
2	OC-3 Optical Line Interface Unit w/TSI	22-type
2	MXRVO Multiplexer CPs	BBG2B
2	STS1E EC-1 CPs	BBG6
2	DS3 CPs	BBG4B
8	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG7/BBG9
1	SYSCTL System Controller	BBG5/BBG8B
1	OC-3 R5, R7/R9/R11/R13/R15 software *	

* Software must be ordered separately. See "Software Ordering" section.

‡ Group B is for R7 and earlier, Group D is for R8 and later, Group E for R13 and later.

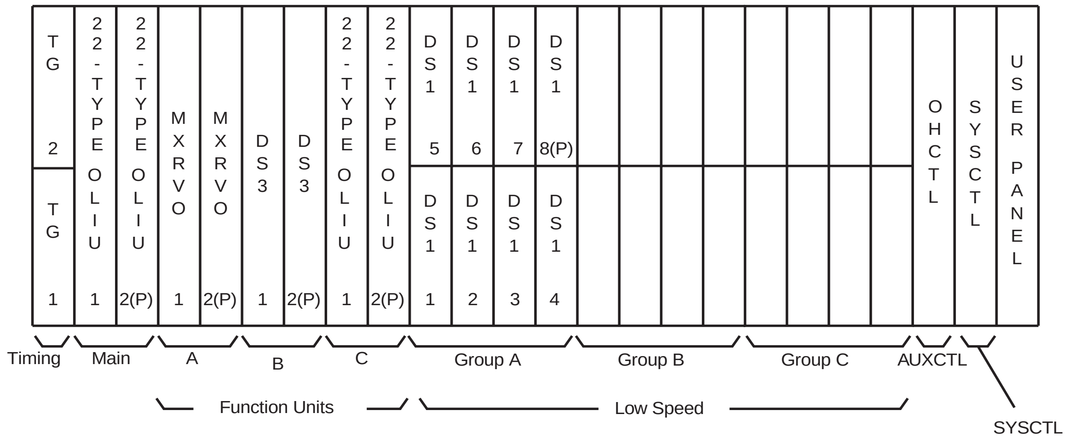


Figure 7-10. OC-3 Ring Shelf Equipped With 28 DS1, 1 DS3, and 1 OC-3 Optical Extension

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, B/D/E ‡
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
4	OC-3 Optical Line Interface Unit w/TSI	22-type
2	MXRVO Multiplexer CPs	BBG2B
2	DS3 CPs	BBG4B
8	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG7/BBG9
1	SYSCTL System Controller	BBG5/BBG8B
1	OC-3 R7/R9/R11/R13/R15 software *	

* Software must be ordered separately. See "Software Ordering" section.

‡ Group B is for R7 and earlier, Group D is for R8 and later, Group E for R13 and later.

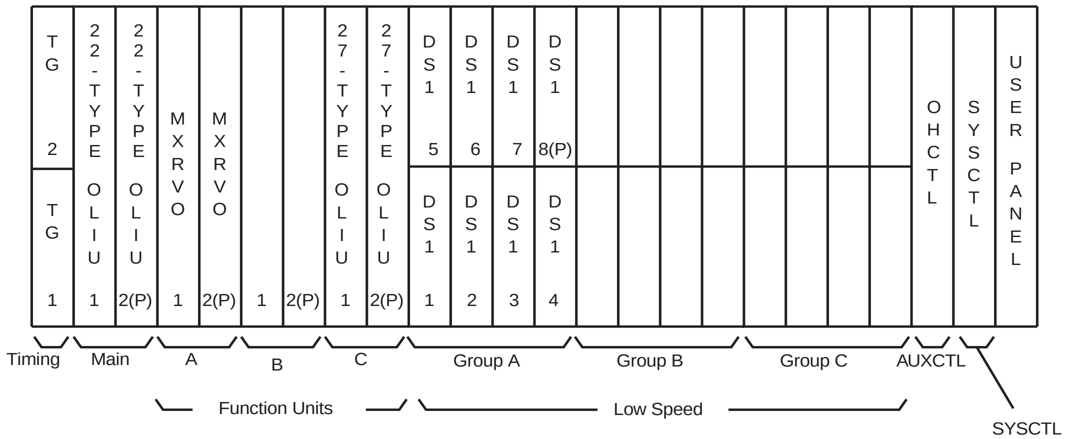


Figure 7-11. OC-3 Ring Shelf Equipped With 28 DS1 Circuits and 2 OC-1 Optical Extensions (DDM-2000 FiberReach Host)

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual †	ED-8C724-30 G4, D/E ‡
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
2	OC-3 Optical Line Interface Unit w/TSI	22-type
2	MXRVO Multiplexer CPs	BBG2B
2	Dual OC-1 OLIUs	27G-U/27G2-U
8	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG9
1	SYSCTL System Controller	BBG8B
1	OC-3 R9/R11/R13/R15 software *	

* Software must be ordered separately. See "Software Ordering" section.

‡ Group D is for R8 and later and Group E for R13 and later.

† The BBF5 is required in Group 1 and Group 3 shelves used as DDM-2000 FiberReach single-homed hosts with 27G-U/27G2-U OLIUs in the function unit slots (Release 9.0 and later). One BBF5 is required in low-speed slot 8 of the low-speed group associated with the function unit where both function unit slots are equipped with 27G-U OLIUs. BBF5 circuit packs are required in slots 4 and 8 of the low-speed group associated with the function unit where both function unit slots are equipped with 27G2-U OLIUs. Use in a Group 3 shelf requires the G3 to G4 Front Cover Modification Kit.

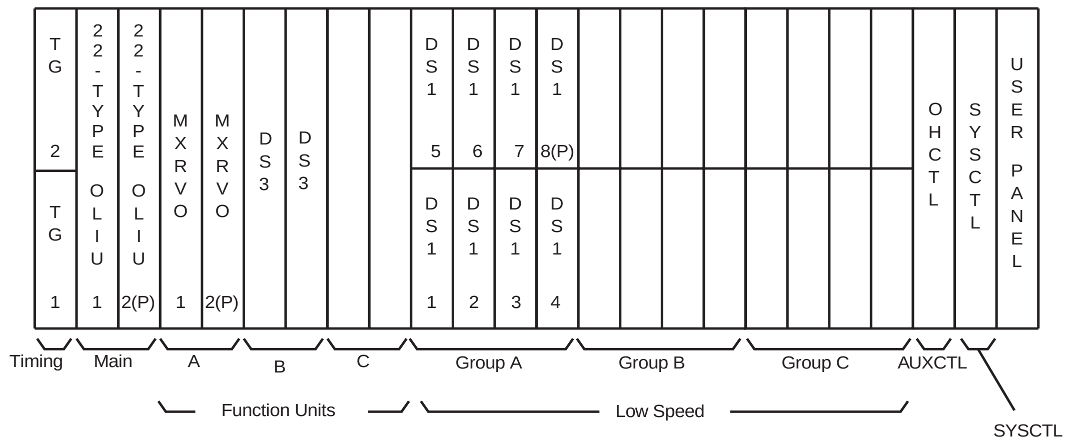


Figure 7-12. MegaStar 2000 Interface Shelf Equipped With 28 DS1 Circuits, 1 DS3

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, D *
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
2	OC-3 Optical Line Interface Unit w/TSI	22-type
2	DS3 CPs	BBG4B
2	MXRVO Multiplexer CPs	BBG2B
8	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG10
1	SYSCTL System Controller	BBG8B
1	OC-3 R8.1/R9.1 software †	

* Group D is for R8.x, R9.x, and R11.x.

† Software must be ordered separately. See "Software Ordering" section.

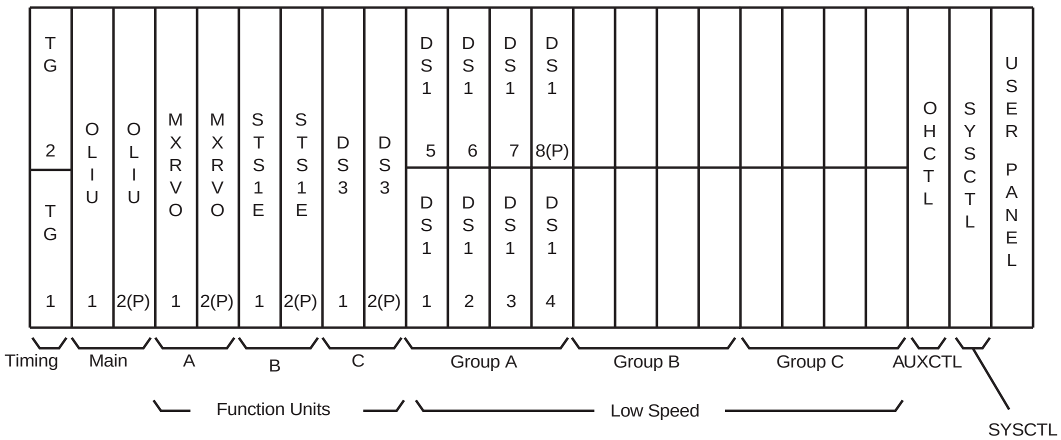


Figure 7-13. OC-3 Shelf with OC-12 Ring Optics, Equipped With 28 DS1, 1 DS3, and 1 EC-1 Circuits

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, D/E †
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
2	OC-12 Optical Line Interface Unit	24G-U/24H-U ‡
2	MXRVO Multiplexer CPs	BBG2B
2	STS1E EC-1 CPs	BBG6
2	DS3 CPs	BBG4B
8	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG9
1	SYSCTL System Controller	BBG8B
1	OC-3 R11/R13 software *	

* Software must be ordered separately. See "Software Ordering" section.

† G3 shelf requires the G3 to G4 front cover upgrade (see Table 7-17) for use with the 24G-U/24H-U. Group D for R8 and later, Group E for R13 and later.

‡ Requires one Interconnect Cable Assembly, 848102287, per pair of 24-type OLIUs, if OLIUs are ordered individually. Alternatively, the OLIU Assembly Kits, 847851367, contains two 24G-U OLIUs and one Interconnect Cable Assembly and 848416269, contains two 24H-U OLIUs and one Interconnect Cable Assembly (see Table 7-17).

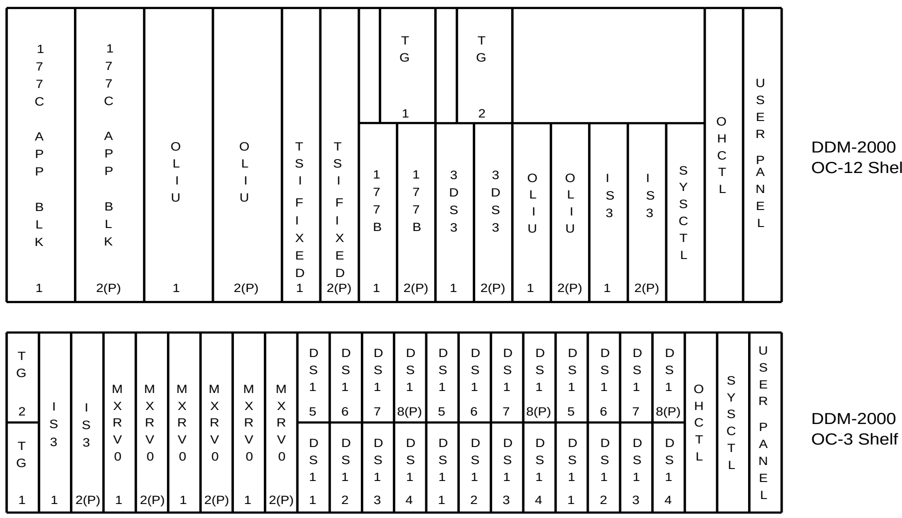


Figure 7-14. OC-3/12 Shelf Equipped With 84 DS1, 3 DS3, and 1 OC-3 Optical Extension

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, B
1	OC-12 Shelf Assembly w/Manual	ED-8C727-30 G1 or G4, A
4	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
2	OC-3 Optical Line Interface Unit	21G2-U/21G3-U
6	MXRVO Multiplexer CPs	BBG2B
2	SYSCTL System Controller	BBG5/BBG8B
24	DS1 CPs	BBF1B or BBF3/BBF3B
1	OC-3 OHCTL Overhead Controller	BBG7
1	OC-12 OHCTL Overhead Controller	BCP1
2	TSI FIXED	BCP2

Quantity	Description	Apparatus/ED Code
2	OC-12 Optical Line Interface Unit	23G-U or 23H-U
4	IS-3 Optical Line Interface Unit	21D-U
2	8 inch App. Blk.	177B
2	12 inch App. Blk.	177C
2	Triple DS3 CPs	BBG11B
1	OC-3 R3 or R6 software *	
1	OC-12 R2 software *	

* Software must be ordered separately. See "Software Ordering" section.

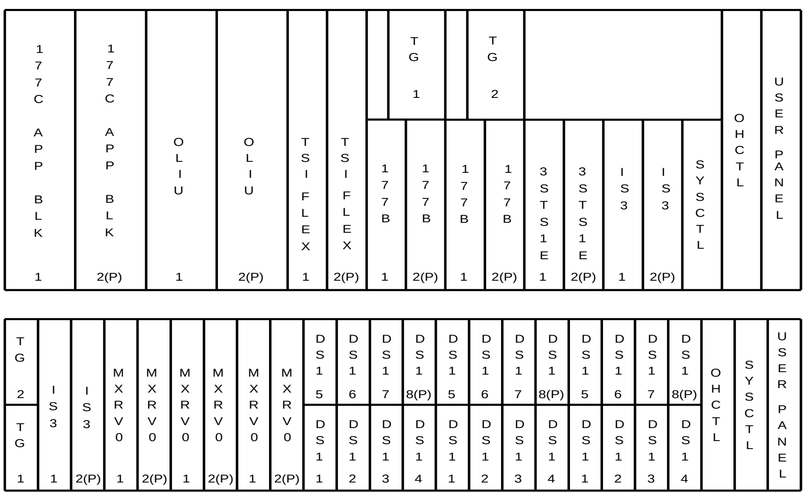


Figure 7-15. OC-3/12 Ring Shelf Equipped With 3 EC-1s and 84 DS1s

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, B/D/E †
1	OC-12 Shelf Assembly w/Manual	ED-8C727-30 G1 or G4, A/D/E †
4	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
6	MXRVO Multiplexer CPs	BBG2B
2	SYSCTL System Controller	BBG5/BBG8B
24	DS1 CPs	BBF1B or BBF3/BBF3B

Quantity	Description	Apparatus/ED Code
1	OC-3 OHCTL Overhead Controller	BBG7/BBG9
1	OC-12 OHCTL Overhead Controller	BCP4
2	TSI FLEX	BCP3
2	OC-12 Optical Line Interface Unit	23G-U or 23H-U
2	IS-3 Optical Line Interface Unit	21D-U
2	Optical Line Interface Unit	22D-U
4	8 inch App. Blk.	177B
2	12 inch App. Blk.	177C
2	Triple STS1E (EC-1s) CPs	BBG12
1	OC-3 R7.1/7.2 or R9/R11/R13 software *	
1	OC-12 R3.1/R5/R5.1/R7.0 software *	

* Software must be ordered separately. See "Software Ordering" section.

† Group E for OC-3 Release 13 and later, OC-12 Release 7 and later.

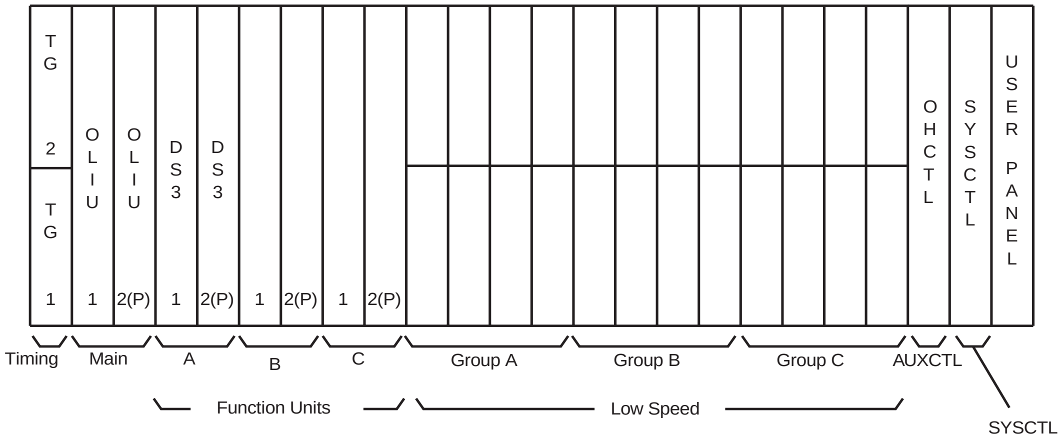


Figure 7-16. OC-3 Shelf with OC-3/OC-12 Optics, Equipped With Data SVCS/NMLI Interface

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, D/E †§
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
2	OC-3/OC-12 Optical Line Interface Unit	22-type, 24-type, or 29-type ‡
2	DS3 Data Interface	BBG19 ¶
1	OHCTL Overhead Controller	BBG9
1	SYSCTL System Controller	BBG8B
1	OC-3 R11/R13/R15 or later software *	

* Software must be ordered separately. See "Software Ordering" section.

† G3 shelf requires the G3 to G4 front cover upgrade (see Table 7-17) for use with the 24G-U/24H-U or 29G-U/29H-U and BBG19s.

‡ Requires one Interconnect Cable Assembly, 848102287, per pair of 24-type or 29-type OLIUs, if OLIUs are ordered individually. Alternatively, the OLIU Assembly Kits, 847851367, contains two 24G-U OLIUs and one Interconnect Cable Assembly, 848416269, contains two 24H-U OLIUs and one Interconnect Cable Assembly, 848345476, contains two 29G-U OLIUs and one Interconnect Cable Assembly, and 848426607, contains two 29H-U OLIUs and one Interconnect Cable Assembly (see Table 7-17).

§ Group E for R13 and later.

¶ BBG19s requires right-angle mini-BNC cable assembly kit. See the Ordering Section of this chapter for cable ED8C724-22, G37 or G38.
A maximum of two function unit slots or four BBG19s are recommended per shelf to address cable congestion and routing issues.

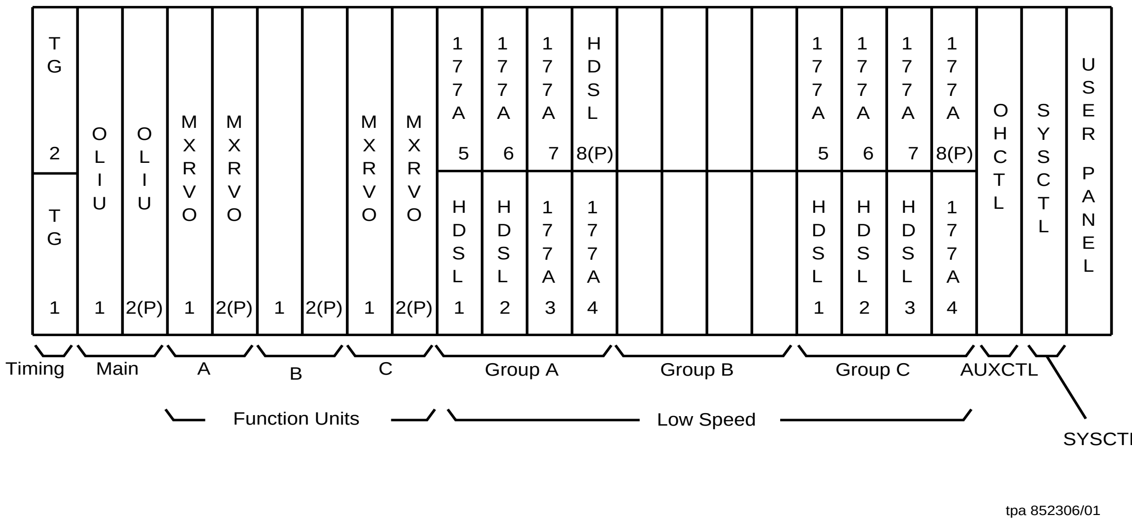


Figure 7-17. OC-3/OC-12 Shelf with HDSL Interface

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, D/E §
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
2	OC-3/OC-12 Optical Line Interface Unit	22-, 24-, or 29-type §
4	MXRVO Multiplexer CPs	BBG2B
6	HDSL *	BBF8 ‡
5	Retainers	177A
1	OHCTL Overhead Controller	BBG9
1	SYSCTL System Controller	BBG8B
1	OC-3 R11.1/R13/R15 or later software †	

* Group A is an example of 1XN (1X2) protection; Group C is unprotected.

† Software must be ordered separately. See "Software Ordering" section.

‡ Maximum number of HDSL interface circuit packs per Function Units group may be increased by using the BBG2B MXRVO. For each BBF8 circuit pack used in outside plant applications, the user should order two LPROT lightning protection cards for use in the lightning and surge protection assembly.

§ G3 shelf requires the G3 to G4 front cover upgrade (see Table 7-16) for use with the 24-type or 29-type OLIUs.
Requires one Interconnect Cable Assembly, 848102287, per pair of 24-type or 29-type OLIUs, if OLIUs are ordered individually. Alternatively, the OLIU Assembly Kits, 847851367, contains two 24G-U OLIUs and one Interconnect Cable Assembly, 848416269, contains two 24H-U OLIUs and one Interconnect Cable Assembly, 848345476, contains two 29G-U OLIUs and one Interconnect Cable Assembly, and 848426607, contains two 29H-U OLIUs and one Interconnect Cable Assembly (see Table 7-16).

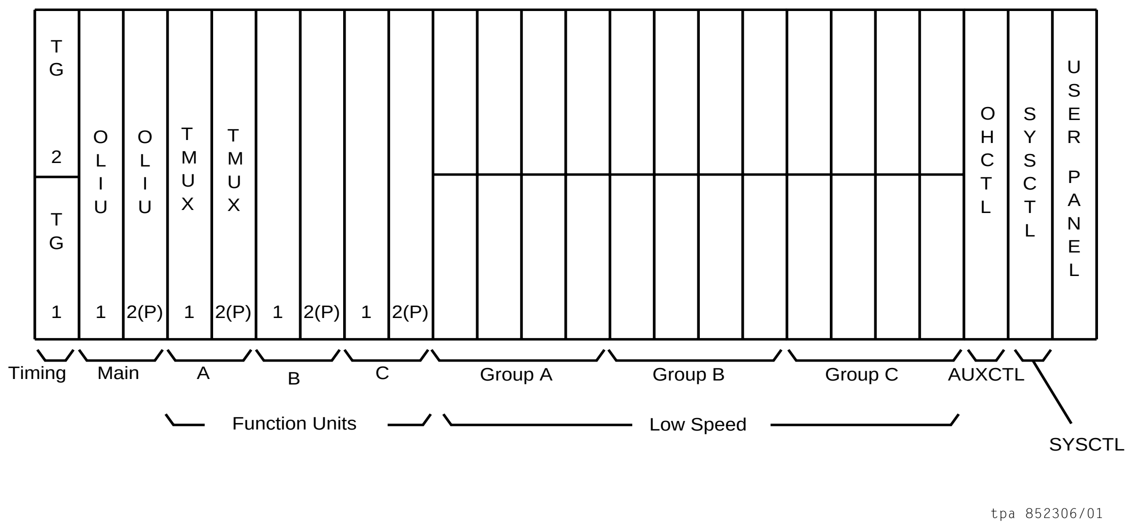


Figure 7-18. OC-3/OC-12 Shelf, Equipped With Transmultiplexer

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, D/E †
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
2	OC-3/OC-12 Optical Line Interface Unit	22-, 24-, or 29-type†
2	Transmultiplexer CPs	BBG20
1	OHCTL Overhead Controller	BBG9
1	SYSCTL System Controller	BBG8B
1	OC-3 R13/R15 or R11.1 software *	

* Software must be ordered separately. See "Software Ordering" section.

† G3 shelf requires the G3 to G4 front cover upgrade (see Table 7-16) for use with the 24-type or 29-type OLIUs.

Requires one Interconnect Cable Assembly, 848102287, per pair of 24-type or 29-type OLIUs, if OLIUs are ordered individually. Alternatively, the OLIU Assembly Kits, 847851367, contains two 24G-U OLIUs and one Interconnect Cable Assembly, 848416269, contains two 24H-U OLIUs and one Interconnect Cable Assembly, 848345476, contains two 29G-U OLIUs and one Interconnect Cable Assembly, and 848426607, contains two 29H-U OLIUs and one Interconnect Cable Assembly (see Table 7-16).

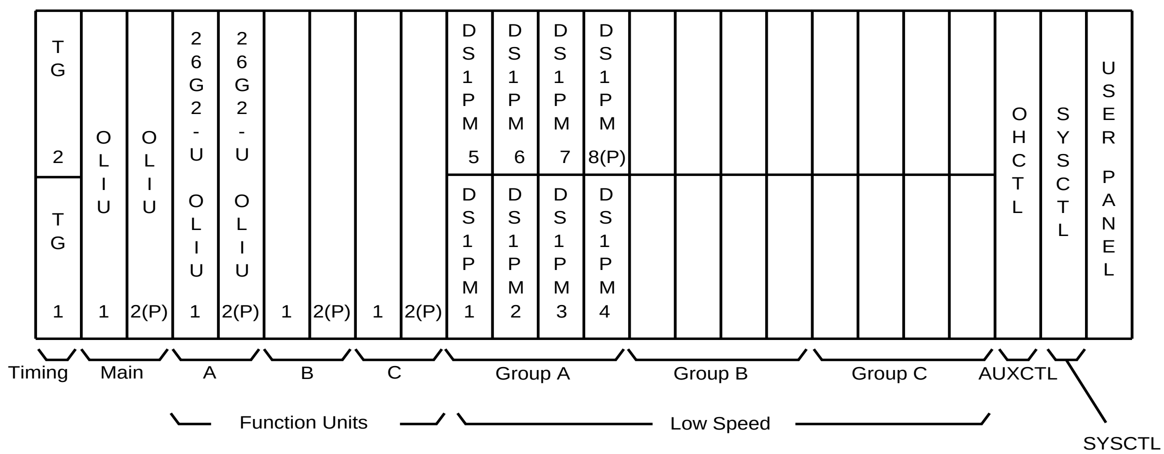


Figure 7-19. OC-3/OC-12 Shelf as FiberReach Host with 26G2-U OLIUs

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, D/E †
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
2	OC-3/OC-12 Optical Line Interface Unit	22-, 24-, or 29-type‡
2	OC-1 Optical Line Interface Unit	26G2-U
8	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG9
1	SYSCTL System Controller	BBG8B
1	OC-3 R13/R15 or R11.1 software *	

* Software must be ordered separately. See "Software Ordering" section.

† The 26G2-U OLIUs require a G4 shelf.

‡ G3 shelf requires the G3 to G4 front cover upgrade (see Table 7-16) for use with the 24-type or 29-type OLIUs.

Requires one Interconnect Cable Assembly, 848102287, per pair of 24-type or 29-type OLIUs, if OLIUs are ordered individually. Alternatively, the OLIU Assembly Kits, 847851367, contains two 24G-U OLIUs and one Interconnect Cable Assembly, 848416269, contains two 24H-U OLIUs and one Interconnect Cable Assembly, 848345476, contains two 29G-U OLIUs and one Interconnect Cable Assembly, and 848426607, contains two 29H-U OLIUs and one Interconnect Cable Assembly (see Table 7-16).

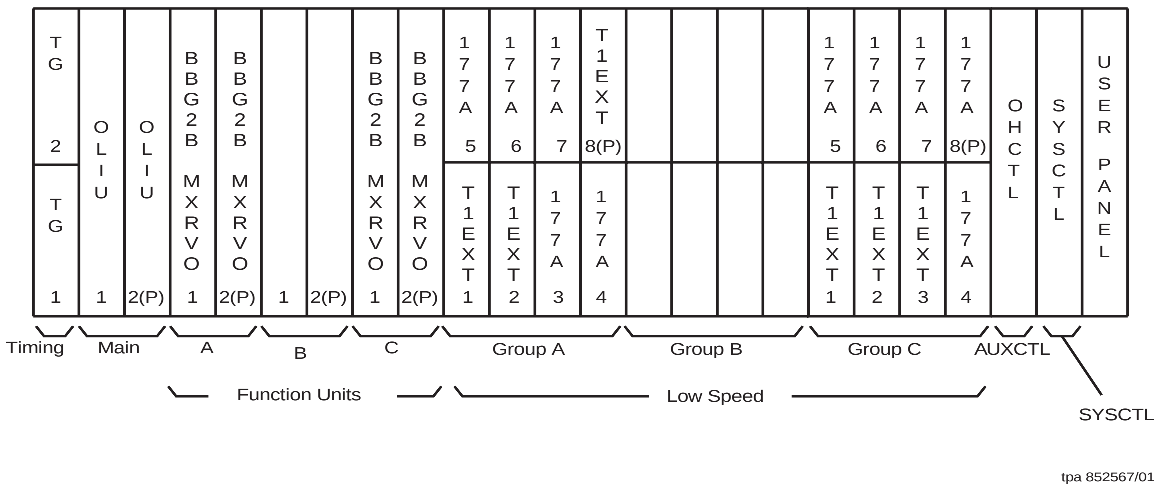


Figure 7-20. OC-3/OC-12 Shelf, T1 Carrier Termination

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, D/E †
2	TGS/TG3Timing Generator	BBF2B/BBF2C/BBF4
2	OC-3/OC-12 Optical Line Interface Unit	22-, 24-, or 29-type †
4	MXRVO Multiplexer CPs	BBG2B
6	T1EXT CPs	BBF6 ‡
10	Retainers	177A
1	OHCTL Overhead Controller	BBG9
1	SYSCTL System Controller	BBG8B
1	OC-3 R15.0 software *	

* Software must be ordered separately. See "Software Ordering" section.

† G3 shelf requires the G3 to G4 front cover upgrade (see Table 7-16) for use with the 24-type or 29-type OLIU.
Requires one Interconnect Cable Assembly, 848102287, per pair of 24-type or 29-type OLIUs, if OLIUs are ordered individually. Alternatively, the OLIU Assembly Kits, 847851367, contains two 24G-U OLIUs and one Interconnect Cable Assembly, 848416269, contains two 24H-U OLIUs and one Interconnect Cable Assembly, 848345476, contains two 29G-U OLIUs and one Interconnect Cable Assembly, and 848426607, contains two 29H-U OLIUs and one Interconnect Cable Assembly (see Table 7-16).

‡ For each BBF6 circuit pack used in outside plant applications, the user should order two LPROT lightning protection cards for use in the lightning and surge protection assembly.

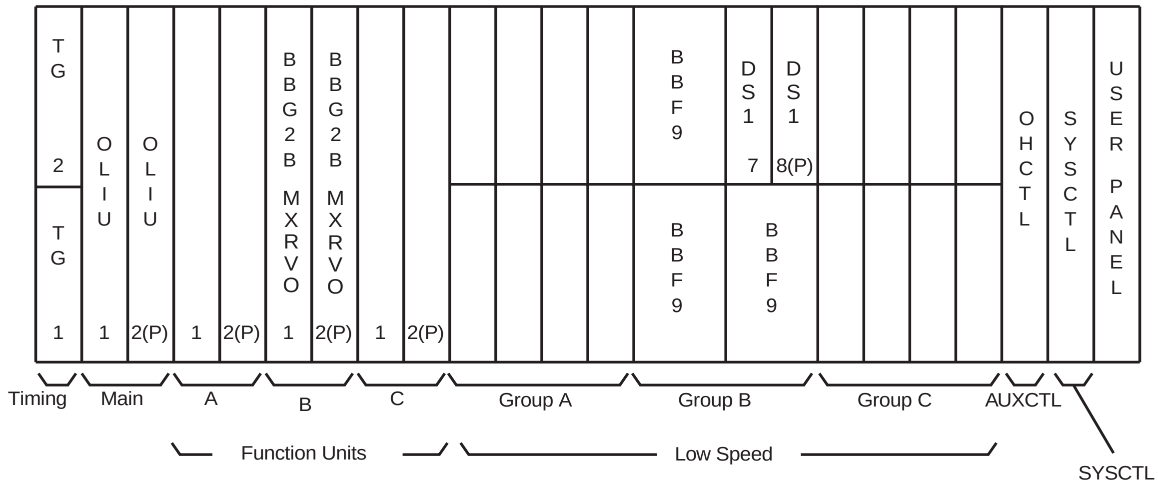


Figure 7-21. OC-3/OC-12 Shelf, LAN Interface

Quantity	Description	Apparatus/ED Code
1	OC-3 Shelf Assembly w/Manual	ED-8C724-30 G4, D/E †
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
2	OC-3/OC-12 Optical Line Interface Unit	22-, 24-, or 29-type †
2	MXRVO Multiplexer CPs	BBG2B
3	LAN CPs	BBF9 or BBF10
2	DS1 CPs	BBF1B or BBF3/BBF3B
1	OHCTL Overhead Controller	BBG9
1	SYSCTL System Controller	BBG8B
1	OC-3 R15.0 software *	

* Software must be ordered separately. See "Software Ordering" section.

† G3 shelf requires the G3 to G4 front cover upgrade (see Table 7-16) for use with the 24-type or 29-type OLIU.

Requires one Interconnect Cable Assembly, 848102287, per pair of 24-type or 29-type OLIUs, if OLIUs are ordered individually. Alternatively, the OLIU Assembly Kits, 847851367, contains two 24G-U OLIUs and one Interconnect Cable Assembly, 848416269, contains two 24H-U OLIUs and one Interconnect Cable Assembly, 848345476, contains two 29G-U OLIUs and one Interconnect Cable Assembly, and 848426607, contains two 29H-U OLIUs and one Interconnect Cable Assembly (see Table 7-16).

Table 7-7 is a table of the maximum number of low-speed circuit pack types that are allowed per low-speed muldem for OC-3 Release 15.

Table 7-8 and Table 7-9 detail the mixing possibilities of low-speed circuit pack types for OC-3 Release 15 for Configurations 1 (BBG2 MXRVO) and 2 (BBG2B MXRVO).

Table 7-7. Maximum Number of Low Speed Circuit Packs per Low Speed Muldem Group in Group 4 or Earlier Shelf for OC-3 Release 15.

	Power		Group 4 or Earlier Shelf	
			BBG2 MXRVO	BBG2B MXRVO
Low Speed Circuit Pack	-48V	+5V	Maximum Number of Circuit Packs Allowed per Low Speed Muldem	
BBF1B DS1	No	Yes	8	8
BBF3B DS1PM	No	Yes	8	8
BBF6 T1EXT	Yes	Yes	0	8
BBF8 HDSL	No	Yes	3	3
BBF9 IMA LAN	Yes	Yes	3	3*
BBF10 IMA LAN	Yes	Yes	2	3*

* Maximum of 6 LAN cards per shelf due to cabling limitations.

Table 7-8. Mixing of Low-Speed Circuit Packs in OC-3 Release 15 for Configuration #1

Configuration #1 - 1 BBG2 MXRVO* in Group 4 or Earlier Shelf																					
Circuit Pack	**Number of Mixed Low-Speed Circuit Packs Allowed Per Low-Speed Muldem Group**																				
BBF1B/BBF3B DS1†	8		7		6	6	6		5	5	5		4	4	4						
BBF6 T1EXT‡	0		0		0	0	0		0	0	0		0	0	0						
BBF8 HDSL	0		0		1	0	0		1	0	0		1	0	0						
BBF9 IMA LAN	0		0		0	1	0		0	1	0		0	1	0						
BBF10 IMA LAN	0		0		0	0	0		0	0	1		0	0	1						
Circuit Pack	**Number of Mixed Low-Speed Circuit Packs Allowed Per Low-Speed Muldem Group**																				
BBF1B/BBF3B DS1†	3	3	3	3	3	3		2	2	2	2	2	2								
BBF6 T1EXT‡	0	0	0	0	0	0		0	0	0	0	0	0								
BBF8 HDSL	2	1	1	0	0	0		2	1	1	0	0	0								
BBF9 IMA LAN	0	1	0	2	1	0		0	1	0	2	1	0								
BBF10 IMA LAN	0	0	0	0	0	1		0	0	1	0	1	2								
Circuit Pack	**Number of Mixed Low-Speed Circuit Packs Allowed Per Low-Speed Muldem Group**																				
BBF1B/BBF3B DS1†	1	1	1	1	1	1		0	0	0	0	0	0	0	0	0	0				
BBF6 T1EXT‡	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0				
BBF8 HDSL	2	1	1	0	0	0		3	2	2	1	1	1	0	0	0	0				
BBF9 IMA LAN	0	1	0	2	1	0		0	1	0	2	1	0	3	2	1	0				
BBF10 IMA LAN	0	0	1	0	1	2		0	0	1	0	1	1	0	1	1	2				

* The mix possibilities will work with only one BBG2 MXRVO, but will need two MXRVOs to power up and to configure the software.

† Circuit packs can be mixed up to the maximum allowed for each type.

‡ BBF6 T1EXT not supported in this configuration (-48V required).

Table 7-9. Mixing of Low-Speed Circuit Packs in OC-3 Release 15 for Configuration #2

Configuration #2 - 1 BBG2B MXRVO* in Group 4 or Earlier Shelf																						
Circuit Pack	**Number of Mixed Low-Speed Circuit Packs Allowed Per Low-Speed Muldem Group**																					
BBF1B/BBF3B DS1/BBF6 T1EXT†	8		7		6	6	6		5	5	5	5		4	4	4	4	4				
BBF8 HDSL	0		0		1	0	0		1	1	0	0		1	1	0	0	0				
BBF9 IMA LAN	0		0		0	1	0		1	0	1	0		1	0	2	1	0				
BBF10 IMA LAN	0		0		0	0	1		0	1	0	1		0	1	0	1	2				
Circuit Pack	**Number of Mixed Low-Speed Circuit Packs Allowed Per Low-Speed Muldem Group**																					
BBF1B/BBF3B DS1/BBF6 T1EXT†	3	3	3	3	3	3	3	3		2	2	2	2	2	2	2	2	2				
BBF8 HDSL	2	2	1	1	1	0	0	0		2	2	1	1	1	0	0	0	0				
BBF9 IMA LAN	1	0	2	1	0	2	1	0		1	0	2	1	0	3	2	1	0				
BBF10 IMA LAN	0	1	0	1	2	0	1	2		0	1	0	1	2	0	1	2	3				
Circuit Pack	**Number of Mixed Low-Speed Circuit Packs Allowed Per Low-Speed Muldem Group**																					
BBF1B/BBF3B DS1/BBF6 T1EXT†	1	1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	0	0			
BBF8 HDSL	2	2	1	1	1	0	0	0	0		3	2	2	1	1	0	0	0	0			
BBF9 IMA LAN	1	0	2	1	0	3	2	1	0		0	1	0	2	1	3	2	1	0			
BBF10 IMA LAN	0	1	0	1	2	0	1	2	3		0	0	1	0	1	0	1	2	3			

* The mix possibilities will work with only one BBG2B MXRVO, but will need two MXRVOs to power up and to configure the software.

† Circuit packs can be mixed up to the maximum allowed for each type. However, it is recommended **not** to mix the BBF6 T1EXT with any other low-speed circuit pack in the same low-speed muldem group.

Table 7-10 is a table of circuit pack types that are allowed by release.

Use Table 7-10 in the following way: Pick one circuit pack from each column to build an application. For example in Release 2.1, there is only one choice for TG, Main, LS GROUP, AUXCTL, and SYSCTL slots. However, any combination of BBG2/BBG2B, BBG4/4B, or 21G2-U/21G3-U OLIUs are allowed in the three function unit slots. Provisioning rules require that both slots of a 1X1 pair have the same circuit pack type and that a DS1 circuit pack requires an MXRVO in the function unit slot. For releases that support multiple low-speed circuit pack types, or two TG circuit pack types, or that support multiple OLIU circuit pack types, these units can be mixed if they follow the provisioning rules.

Table 7-10. DDM-2000 OC-3 Mux Circuit Pack and Software Compatibility Matrix

Release Number	Slot Name TG	Main	Fn-A	Fn-B	Fn-C	LS Group*	AUXCTL	SYSCTL
2.1¶¶ (Linear)	BBF2¶¶ BBF2B BBF2C §§§§	21G/21G-U¶¶ 21G2-U 21G3-U	BBG2/BBG2B BBG4/4B 21G/21G-U¶¶ 21G2-U 21G3-U	BBG2/BBG2B BBG4/4B 21G/21G-U¶¶ 21G2-U 21G3-U	BBG2/BBG2B BBG4/4B 21G/21G-U¶¶ 21G2-U 21G3-U	BBF1¶¶ BBF1B	BBG7	BBG5
3.1¶¶ (Linear)	BBF2¶¶ BBF2B† BBF2C §§§§	21G/21G-U¶¶ 21G2-U 21G3-U 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B 21G/21G-U¶¶ 21G2-U 21G3-U 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B 21G/21G-U¶¶ 21G2-U 21G3-U 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B 21G/21G-U¶¶ 21G2-U 21G3-U 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBF1¶¶ BBF1B	BBG7	BBG5
3.2 (Linear)	BBF2¶¶ BBF2B† BBF2C §§§§	21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B 21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B 21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B 21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBF1¶¶ BBF1B BBF8	BBG7	BBG5
5.1 ** ¶¶ (Ring)	BBF2¶¶ BBF2B† BBF2C §§§§	22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG4/4B BBG2/BBG2B BBG6(ls)¶	BBG4/4B BBG2/BBG2B BBG6(ls)¶	BBG4/4B BBG2/BBG2B BBG6(ls)¶	BBF1¶¶ BBF1B BBF3/ BBF3B‡	BBG7§§	BBG5

Release Number	Slot Name							
	TG	**Main**	**Fn-A**	**Fn-B**	**Fn-C**	**LS Group***	**AUXCTL**	**SYSCTL**
6.0 ¶¶ and 6.2 (Linear)	BBF2¶¶ BBF2B† BBF2C §§§§	21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B BBG6(hs)§ BBG6(ls)¶ 21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B BBG6(hs)§ BBG6(ls)¶ 21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B BBG6(hs)§ BBG6(ls)¶ 21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBF1¶¶ BBF1B BBF3/ BBF3B‡ BBF8	BBG7††	BBG5
7.0 ** ¶¶ 7.1 and 7.2** (Ring)**	BBF2¶¶ BBF2B† BBF2C §§§§	22F/22F-U/ 22F2-U ‡‡ 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B*** BBG6(ls)¶	BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBF1¶¶ BBF1B BBF3/ BBF3B‡ BBF8	BBG7§§	BBG5
8.0 ¶¶ and 8.1 (Linear)	BBF2 BBF2B† BBF2C §§§§	21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B*** BBG6(hs)§ BBG6(ls)¶ 21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B*** BBG6(hs)§ BBG6(ls)¶ 21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBG2/BBG2B BBG4/4B*** BBG6(hs)§ BBG6(ls)¶ 21G/21G-U¶¶ 21G2-U 21G3-U 21D/21D-U¶¶ 22F/22F-U/ 22F2-U 22D-U 22G-U/22G2-U 22G3-U 22G4-U	BBF1B BBF3/ BBF3B‡ BBF8	BBG9 BBG10 ¶¶¶	BBG8/ BBG8B
9.0 and 9.1 (Ring)**	BBF2 BBF2B† BBF2C §§§§	22F/22F-U/ 22F2-U‡‡ 22D-U 22G-U/22G2-U 22G3-U 22G4-U 27G-U/ 27G2-U§§§	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 27G-U/ 27G2-U§§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 27G-U/ 27G2-U§§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 27G-U/ 27G2-U§§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶	BBF1B BBF3/ BBF3B‡ BBF5††† BBF8	BBG9	BBG8/ BBG8B

Release Number	Slot Name							
	TG	**Main**	**Fn-A**	**Fn-B**	**Fn-C**	**LS Group***	**AUXCTL**	**SYSCTL**
11.0** **(Ring)**	BBF2 BBF2B† BBF2C §§§	22F/22F-U/ 22F2-U‡‡ 22D-U 22G-U/22G2-U 22G3-U 22G4-U 24G-U‡‡‡ 24H-U‡‡‡ 27G-U/ 27G2-U§§	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 27G-U/ 27G2-U§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19††††	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 27G-U/ 27G2-U§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19††††	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 27G-U/ 27G2-U§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19††††	BBF1B BBF3/ BBF3B‡ BBF5††† BBF8	BBG9 BBG10 ¶¶¶	BBG8/ BBG8B
11.1** **(Ring)**	BBF2 BBF2B† BBF2C BBF4 §§§	22F/22F-U/ 22F2-U‡‡ 22D-U 22G-U/22G2-U 22G3-U 22G4-U 24G-U‡‡‡ 24H-U‡‡‡ 27G-U/ 27G2-U§§	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 26G2-U**** 27G-U/ 27G2-U§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19†††† BBG20	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 26G2-U**** 27G-U/ 27G2-U§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19†††† BBG20	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 26G2-U**** 27G-U/ 27G2-U§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19†††† BBG20	BBF1B BBF3/ BBF3B‡ BBF5††† BBF8 ‡‡‡‡	BBG9	BBG8/ BBG8B
13.0** **(Ring)**	BBF2 BBF2B† BBF2C BBF4 §§§	22F/22F-U/ 22F2-U‡‡ 22D-U 22G-U/22G2-U 22G3-U 22G4-U 24G-U‡‡‡ 24H-U‡‡‡ 27G-U/ 27G2-U§§	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 26G2-U**** 27G-U/ 27G2-U§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19†††† BBG20	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 26G2-U**** 27G-U/ 27G2-U§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19†††† BBG20	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 26G2-U**** 27G-U/ 27G2-U§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19†††† BBG20	BBF1B BBF3/ BBF3B‡ BBF5††† BBF8 ‡‡‡‡	BBG9	BBG8/ BBG8B

Release Number	TG	Main	Fn-A	Fn-B	Fn-C	LS Group*	AUXCTL	SYSCTL
	Slot Name							
15.0** **(Ring)**	BBF2 BBF2B† BBF2C BBF4 §§§§	22F/22F-U/ 22F2-U‡‡ 22D-U 22G-U/22G2-U 22G3-U 22G4-U 24G-U‡‡‡ 24H-U‡‡‡ 27G-U/ 27G2-U§§§ 29G-U‡‡‡ 29H-U‡‡‡	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 26G2-U**** 27G-U/ 27G2-U§§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19†††† BBG20	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 26G2-U**** 27G-U/ 27G2-U§§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19†††† BBG20	22D-U 22F/22F-U/ 22F2-U 22G-U/22G2-U 22G3-U 22G4-U 26G2-U**** 27G-U/ 27G2-U§§§ BBG2/BBG2B BBG4/4B*** BBG6(ls)¶ BBG19†††† BBG20	BBF1B BBF3/ BBF3B‡ BBF5††† BBF6 BBF8 BBF9 BBF10 ‡‡‡‡	BBG9	BBG8/ BBG8B

* 177A Retainer card must be installed in unused slots of a partially equipped muldem. Not required with BBF5.

† The BBF2B circuit pack optionally provides DS1 timing outputs. It is recommended for rings to minimize protection switching times in case of a manual circuit pack removal.

‡ The BBF3 is the DS1PM circuit pack which can be used in place of or mixed with the BBF1/1B. If mixed within a low-speed group the protection circuit pack must be a BBF3. If the DS1PM feature is "enabled" using the **`set-feat`** command, the BBF3 has additional performance monitoring capabilities. The BBF3B can perform individual DS1 loopbacks using R13 or later.

§ The BBG6(hs) is the BBG6 circuit pack with its switch set for high-speed.

¶ The BBG6(ls) is the BBG6 circuit pack with its switch set for low-speed.

** The 22-type OLIUs used in ring Releases R5.x, R7.x, R9.x, R11.x and R13.x must be present in main-1 and main-2 for proper ring operation. If signal degrade protection is not used, the 22F/22F-U and 22G-U/22G2-U OLIUs can be mixed in the same shelf. The 22F2-U provides signal degrade protection switching and can be mixed with 22G-U/22G2-U/22G3-U/22G4-U OLIUs. The BBF2B TGS is recommended for rings to minimize protection switching times in case of a manual circuit pack removal.

†† Must be Series 2:3 or later.

‡‡ Signal degrade protection switching requires 22D-U or 22G-U/22G2-U/22G3-U/22G4-U or 22F2-U OLIUs.

§§ Must be Series 2:4A or later.

¶¶ Software Releases R2.1, R3.1, R5.0, R5.1, R6.0, R6.1, R7.0, R8.0 and the BBF1, BBF2, BBG4, 21G, 21G-U, 21D, 22F, 22F-U, 22F2-U and 22G-U circuit packs have been rated discontinued availability (DA).

*** BBG4B DS3 required in Releases 7.2 and later to support enhanced DS3 performance monitoring.

††† Required in Group 1 and Group 3 shelves functioning as DDM-2000 FiberReach hosts with 27G-U/27G2-U OLIUs.

‡‡‡ When 24-type or 29-type OLIUs are used in a G3 shelf (the OLIUs must be deployed in pairs), the front cover must be modified using the G3 to G4 Front Cover Modification Kit. See page 7-7, Table 7-1. The 24-type and 29-type OLIUs also require an Interconnect Cable Assembly 848102287.

§§§ The 27G2-U is required for some enhanced FiberReach host topologies with Releases 9.1 and 11.0. When the 27G-U/27G2-U is used in a G3 shelf, the front cover must be modified using the G3 to G4 Front Cover Modification Kit. See page 7-7, Table 7-1.

¶¶¶ The BBG10 is required for Release 8.1 and Release 9.1 *MegaStar* applications only.

**** 26G2-U requires OC-3 Group 4 Shelf.

†††† Due to cable congestion, it is recommended that no more than four BBG19s be used per shelf. A G4 shelf or G3 to G4 Front Cover Modification Kit is required.

‡‡‡‡ Up to three BBF8s can be installed per low-speed group. Future enhancements may support higher density.

§§§§ The BBF4 TG3 is not compatible with the BBF2/BBF2B/BBF2C TGS.

Note: The following circuit packs require the G4 Shelf, or G3 to G4 Front Cover Upgrade Kit: 24G-U/24H-U OLIU, 29G-U/29H-U OLIUs, 27G-U/27G2-U OLIUs, 26G2-U OLIU (always requires G4 Shelf for backplane compatibility), and BBG19 DS3. Additionally, the G3 to G4 upgrade kit is recommended wherever fiber contusion and/or cable dressing is a concern.

Plug-In Maintenance Sparing Guidelines

Table 7-11 provides a guideline for determining the number of DDM-2000 OC-3 plug-in spares needed for a given number of plug-ins in the field. The sparing guide serves as an initial estimate and is calculated with the following assumptions:

- The method for calculating spares follows the procedure described in Telcordia Technologies TR-TSY-000385, Issue 1.
- The steady-state failure rate is assumed. Failure rates are based on the reliability prediction procedure (RPP) method described in TR-TSY-000332, Issue 4.
- The spare availability objective (SAO) is 99 percent. The SAO is the long-term probability that a spare plug-in is available when it is needed.
- A no-trouble-found (NTF) factor of 1.67 is multiplied to the failure rate. This accounts for replacements of plug-ins when actually no failure has occurred. The NTF factor is expected to approach 1.25 as the product matures. The likelihood of an NTF decreases as the product matures, and sparing needs will therefore diminish over time.
- Turnaround time of a returned plug-in is two weeks.

Table 7-11 shows how many plug-ins in the field can be supported by a given number of spares (NS).

Table 7-11. Sparing Guidelines

Plug-In Code	Number of Spares					
	NS=1	NS=2	NS=3	NS=4	NS=5	NS=6
BBF1 (DS1)	335	1029	1962	3038	4258	5502
BBF1B (DS1)	290	892	1701	2635	3693	4772
BBF2 (TGS)	91	280	534	826	1158	1497
BBF2B (TGS)	108	332	632	979	1373	1774
BBF2C (TGS)	106	327	623	965	1353	1748
BBF3 (DS1PM)	190	585	1116	1728	2472	3129
BBF3B (DS1PM)	202	621	1183	1833	2569	3319
BBF4 (TG3)	106	327	623	965	1353	1748
BBF5 (JUMPER)	—	—	—	—	—	—
BBF6 (T1EXT)	175	537	1024	1586	2223	2872
BBF8 (HDSL)	48	147	280	434	608	786
BBF9 (LAN)	122	376	717	1111	1557	2012
BBF10 (LAN)	110	337	642	994	1393	1800
BBG2 (MXRVO)	277	850	1620	2509	3517	4544
BBG2B (MXRVO)	304	935	1782	2760	3869	4999
BBG4 (DS3)	277	850	1620	2509	3517	4544
BBG4B (DS3)	236	726	1384	2143	3004	3882
BBG5 (SYSCTL)	47	145	277	428	600	776
BBG6 (STS1E EC-1)	114	349	666	1032	1447	1869
BBG7 (OHCTL)	73	223	426	659	924	1194
BBG8 (SYSCTL)	55	170	324	502	704	910
BBG8B (SYSCTL)	56	173	329	510	714	923
BBG9 (OHCTL)	61	188	358	554	777	1004
BBG10 (OHCTL)	57	174	331	513	719	930
BBG19 (DS3)	342	1051	2005	3105	4351	5623
BBG20 (TMUX)	38	117	223	346	484	626
21D (OLIU)	127	391	746	1155	1619	2092
21D-U (OLIU)	184	566	1078	1670	2341	3025
21G (OLIU)	39	121	230	357	500	646

Table 7-11. Sparing Guidelines

Plug-In Code	Number of Spares					
	NS=1	NS=2	NS=3	NS=4	NS=5	NS=6
21G-U (OLIU)	97	297	567	878	1230	1590
21G2-U (OLIU)	61	188	358	554	776	1003
21G3-U (OLIU)	141	433	827	1280	1794	2318
22F (OLIU)	75	231	441	682	956	1236
22F2-U (OLIU)	123	377	719	1113	1560	2016
22D-U (OLIU)	127	391	746	1155	1619	2092
22G-U (OLIU)	87	266	507	786	1101	1423
22G2-U (OLIU)	80	245	467	724	1014	1311
22G3-U (OLIU)	61	188	358	555	778	1005
22G4-U (OLIU)	175	537	1025	1587	2225	2874
24G-U (OLIU)	120	368	703	1088	1525	1971
24H-U (OLIU)	104	321	612	948	1328	1716
26G-U (OLIU)	120	368	703	1088	1525	1971
26G2-U (OLIU)	99	303	579	896	1256	1623
27G-U (Dual OC-1 OLIU)	78	241	460	712	998	1289
27G2-U (Dual OC-1 OLIU)	88	271	518	802	1124	1452
29G-U (OLIU)	76	233	445	689	966	1248
29H-U (OLIU)	82	251	480	744	1043	1347
Fan Shelf	25	78	148	229	321	415
Fan Pack	125	383	731	1132	1586	2049

* Not available at time of issue.

Example:

- Plug-in code = BBF2B
- Plug-in population = between 100 and 242
- Number of spares = 2 (NS=2).

Table 7-12 is a worksheet for the OC-3 shelf, showing the number of plug-ins allowed. After calculating the number required, transfer these numbers to the OC-3 Plug-In Order Blank, Table 7-14.

Table 7-12. OC-3 Plug-in Worksheet (Per Shelf)

Slot Name	**Product Codes**	**Min/Shelf** *	**Max/Shelf** *	**Qty Ordered**
TG	BBF2B/BBF2C/BBF4	2	2	
Main OLIU ¶	21D-U or 21G-U/21G2-U/21G3-U or 22D-U or 22G3-U/22G4-U or 24G-U/ 24H-U 27G-U/27G2-U or 29G-U/29H-U	2	2	
Function Unit §	BBG2B or BBG4B or BBG6 or BBG19 or BBG20 or 21D-U or 21G-U/21G2-U/21G3-U or 22D-U or 22G3-U/22G4-U or 26G2-U or 27G-U/27G2-U	2	6 4 6	
Low Speed	BBF1B or BBF3/BBF3B ** or BBF6 or BBF5 ‡‡or BBF8 or BBF9 or BBF10 177A ††	0 1 or 2 0	24 2 9 6	
Auxctl	BBG9/BBG10 †	1	1	
Sysctl	BBG8B †	1	1	

* Minimum and maximum quantities per shelf, as defined here, include protection switching capability: thus protection plug-ins are included.

† The BBG8/BBG8B and BBG9 must be used as a pair, or the BBG8/BBG8B and BBG10 must be used as a pair (R8.1 and R9.1 only. Used with *MegaStar* 2000).

§ 21-type OLIUs cannot be mixed with 22-type OLIUs in the same shelf.

¶ The minimum number of circuit packs in the MAIN OLIU slot could be 0 if the shelf is configured in the electrical SONET mode (DS1 to EC-1). Otherwise, two of any OLIU type are required.

** If the BBF3/BBF3B DS1PM circuit pack is equipped and circuit pack protection is desired, the protection pack must be a BBF3/BBF3B for that MULDEM.

†† Unequipped DS1 service slots in an in-service low-speed group must be terminated with 177A retainers; that is, the sum of service DS1 plug-ins and 177A retainers must total eight per low-speed group.

‡‡ Minimum required is one per function unit group equipped with 27G-U OLIUs or when used in a G1 or G3 shelf. Minimum of two required when equipped with 27G2-U OLIU. Never required with G4 shelf.

Universal Optical Connectors

All the DDM-2000 OC-3 OLIUs have a new universal optical connector (Figure 7-22). This connector is a two-part connector consisting of a faceplate-mounted block and an optical buildout. The faceplate block optionally supports an *ST*, SC, or FC-PC type optical buildout.

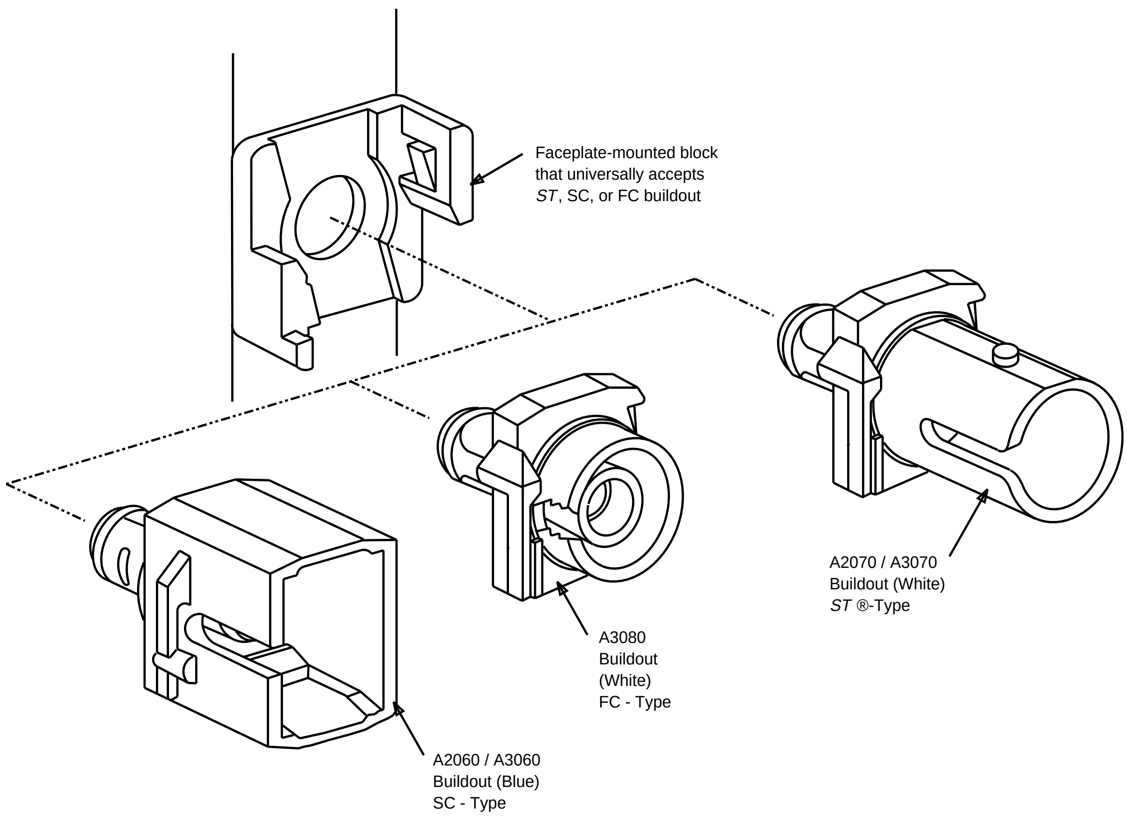


Figure 7-22. Universal Optical Connector

A 0 dB SC-type connector is shipped as standard with each OLIU. Optional SC, *ST*, or FC-PC 0 dB or attenuated buildouts can be ordered separately as listed in Table 7-13. Table 7-13 lists single-mode (SM) and multimode (MM) 0 dB and attenuated buildouts.

The 22G-U OLIU needs a 10 dB attenuator for loopback testing. The 26G2-U/ 27G-U/27G2-U OLIUs require a 15 dB attenuator for loopback testing. See the "OC-3 Ordering — Miscellaneous Equipment and Tools" section for ordering information.

Note that some OLIUs may need line buildouts for end-to-end budget loss. See Section 11, “Technical Specifications,” for further information.

Table 7-13. Universal Buildout Attenuators

Description	Connection	Loss (dB)	Comcode
A3060 SC 0 dB buildout	SM-SM & MM-MM	0	106708951
A3060B1 SC 5 dB buildout	SM-SM	5	107406142
A3060D1 SC 10 dB buildout	SM-SM	10	107406159
A3060F1 SC 15 dB buildout	SM-SM	15	107406167
ASCM5 SC 5 dB buildout	SM-MM	5	108440579
ASCM10 SC 10 dB buildout	SM-MM	10	108440595
ASCM15 SC 15 dB buildout	SM-MM	15	108440611
ASCM20 SC 20 dB buildout	SM-MM	20	108440637
A3070 *ST*® 0 dB buildout	SM-SM & MM-MM	0	106795354
A3070B1 *ST* 5 dB buildout	SM-SM	5	107406183
A3070D1 *ST* 10 dB buildout	SM-SM	10	107406191
A3070F1 *ST* 15 dB buildout	SM-SM	15	107406209
ASTM5 SC 5 dB buildout	SM-MM	5	108052960
ASTM10 SC 10 dB buildout	SM-MM	10	108052994
ASTM15 SC 15 dB buildout	SM-MM	15	108053018
ASTM20 SC 20 dB buildout	SM-MM	20	108053042
A3080 FC 0 dB buildout	SM-SM & MM-MM	0	106795404
A3080B1 FC 5 dB buildout	SM-SM	5	107406225
A3080D1 FC 10 dB buildout	SM-SM	10	107406233
A3080F1 FC 15 dB buildout	SM-SM	15	107406241
AFCM5 FC 5 dB buildout	SM-MM	5	108107285
AFCM10 FC 10 dB buildout	SM-MM	10	108107301
AFCM15 FC 15 dB buildout	SM-MM	15	108107327
AFCM20 FC 20 dB buildout	SM-MM	20	108107343
A2060B SC 5 dB buildout	MM-MM	5	106795271
A2060D SC 10 dB buildout	MM-MM	10	106795289
A2060F SC 15 dB buildout	MM-MM	15	106795297
A2070B *ST* 5 dB buildout	MM-MM	5	106795313
A2070D *ST* 10 dB buildout	MM-MM	10	106795321
A2070F *ST* 15 dB buildout	MM-MM	15	106795339

Table 7-14. DDM-2000 OC-3 Plug-In Order Blank

DDM-2000 OC-3 PLUG-IN ORDER BLANK

Qty Ord	Product Code	Comcode	CLEI * Code	Functional Name	Functional Designation
	BBF1B	106543606	SN3PFGEEAA	DS1 low-speed interface	DS1
	BBF2C	108230731	SNPQB4XAAB	Synchronous timing generator	TGS
	BBF3B	107966582	SNPQB03AAB	DS1 Performance Monitoring	DS1PM
	BBF4	106008089	SN3PGHFEAA	Synchronous timing generator	TG3
	BBF5 †	107392334	SNPQBLAAAA	Jumper Circuit Pack	JUMPER
	BBF6	107436610	SNC3AA0AAA	T1 Extension	T1EXT
	BBF8 ‡	108038035	SNCRLP0CAA	HDSL Interface	HDSL
	BBF9	109188151	SNCBZ05DAA	Electrical LAN	LAN
	BBF10	109188169	SNPQCR0AAA	Optical LAN	LAN
	BBG2B	108247990	SNPQB5PAAB	VT-to-STS-1 multiplexer	MXRVO
	BBG4B §	107486490	SNPQBMFAAA	DS3 low-speed interface	DS3
	BBG6	106008097	SNPQWAEAAA	EC-1 Interface	STS1E
	BBG8B	107830549	SNC5U79DAB	System controller	SYSCTL
	BBG9 ¶	106008121	SNC11VLAAB	Overhead controller	OHCTL
	BBG10 ††	108321662	SNP2609DAB	Overhead controller	OHCTL
	BBG19 ‡‡	107834814	SNI2540BAA	DS3 data services interface	DS3
	BBG20	107870248	SNCBFU0DAA	Transmux	TMUX
	21D-U §§	107092637	SNRXDJ0DAA	OC-3 IS-3 OLIU	OLIU
	21G3-U ¶¶	108215484	SNRXDRPAAA	OC-3 Optical Line Interface Unit	OLIU
	22G4-U	108215492	SNRXDZNAAA	OC-3 OLIU w/TSI	OLIU
	22D-U §§	106926595	SNCMVE0AAA	OC-3 IS-3 OLIU w/TSI	OLIU
	24G-U ††† ‡‡‡	107735086	SNRXDW0AAA	OC-12 OLIU w/TSI	OLIU
	24H-U ††† ‡‡‡	108218702	SNRXDWSAAA	OC-12 OLIU w/TSI	OLIU

Table 7-0. DDM-2000 OC-3 Plug-In Order Blank (Contd)

DDM-2000 OC-3 PLUG-IN ORDER BLANK

Qty Ord	Product Code	Comcode	CLEI * Code	Functional Name	Functional Designation
	26G2-U	107727745	SNC6JG0EAAA	OC-1 OLIU w/TSI	OLIU
	27G2-U§§§	107727752	SNC6JH0EAB	Dual OC-1 OLIU	OLIU
	29G-U†††	108219114	SNRXD70AAA	OC-12 OLIU w/TSI	OLIU
	29H-U†††	108523580	SNRXD7TAAA	OC-12 OLIU w/TSI	OLIU
	177A	105774061	SNPQWACAAB	Retainer	

* Humans Equipment Catalog Item.

† The BBF5 is required in Group 1 and Group 3 shelves used as DDM-2000 FiberReach single-homed hosts with 27G-U/27G2-U OLIUs in the function unit slots (Release 9.0 and later). One BBF5 is required in low-speed slot 8 of the low-speed group associated with the function unit where both function unit slots are equipped with 27G-U OLIUs. BBF5 circuit packs are required in slots 4 and 8 of the low-speed group associated with the function unit where both function unit slots are equipped with 27G2-U OLIUs. The Group 3 shelf requires the G3 to G4 Front Cover Modification Kit.

‡ BBF8 allows a maximum of three packs — 2 service, 1 protection (or 3 unprotected) — per function unit group. The BBF8 interfaces with PairGain™ CPE equipment.

To order compatible PairGain CPE equipment contact:

PairGain Technologies
14402 Franklin Avenue
Tustin, CA 92780-7013
Customer Service # 1-800-638-0031

§ Required in Releases 7.2 and later to support enhanced DS3 performance monitoring.

¶ Required in Release 8.0 and later releases.

†† Required with Release 8.1 and Release 9.1 *MegaStar* applications only.

‡‡ BBG19 requires front access right angle mini-BNC Cable Assembly. See Figure 7-2-5 (DDM-2000 OC-3 Front Access Cabling) for ordering info. Use in a Group 3 shelf requires the G3 to G4 Front Cover Modification Kit.

§§ Shipped with 0 dB *ST* buildout. See Table 7-13 if other connector types or attenuators are needed.

¶¶ The 21G2-U eliminates the hi/low power switch. It replaces the 21G-U.

††† OLIU Assembly Kit required. Includes two 24-type or 29-type OLIUs and one Interconnect Cable Assembly. (Interconnect Cable Assembly can also be ordered separately.) See Table 7-17. Use in a Group 3 shelf requires the G3 to G4 Front Cover Modification Kit. Requires 24G-U/24H-U/29G-U/29H-U Interconnect Cable Assembly (848102287) between OLIU pairs.

§§§ DDM-2000 FiberReach host shelves (Release 9.0 and later). Shipped with 0 dB *ST* buildout. See Table 7-13 if other connector types or attenuators are needed. Requires 15 dB attenuation for loopback testing. 27G2-U required for some R9.1 and later applications.

Table 7-15. DDM-2000 OC-3 Discontinued Availability (DA) Plug-Ins

DDM-2000 OC-3 DISCONTINUED AVAILABILITY (DA) PLUG-INS

DA Product Code	Comcode	DA Date	Replacement Code	Comcode
BBF2B	106995046		BBF2C	108230731
BBF3 DS1PM	106008071	3/00	BBF3B DS1PM	107966582
BBG2 MXRVO	106439409	11/98	BBG2B MXRVO	108247990
BBG5 SYSCTL§	106633688	12/98	BBG5 SYSCTL	107822553 *
BBG7 OHCTL	106633704	12/98	BBG7 OHCTL	107835282 *
BBG8 SYSCTL	106008113	9/97	BBG8B SYSCTL	107830549
22F OLIU	106305386	6/97	22G3-U OLIU	108057944
22F-U OLIU	107713836	2/99	22G3-U OLIU	108057944
22F2-U OLIU	107762809	2/98	22G3-U OLIU	108057944
21G-U OLIU	107092645	1/98	21G2-U OLIU	107931628
21G2-U OLIU	107931628	2/00	21G3-U OLIU	108215484
22G-U OLIU	107012627	9/95	22G3-U OLIU	108057944
22G2-U OLIU	107432403	2/98	22G3-U OLIU	108057944
22G3-U OLIU	108057944		22G4-U OLIU	108215492
26G-U OLIU	108010513	1/98	26G2-U OLIU	107727745
27G-U OLIU	107306235	5/00	27G2-U OLIU	107727752

* These replacement circuit packs are subject to availability through: Special Customer Operations (SCO), 1-888-900-EOLC, www.lucent-sco.com.

Miscellaneous Equipment and Tools

Although the DDM-2000 OC-3 Multiplexer was designed with built-in self-test capability for facilitating installation and normal maintenance routines and troubleshooting, certain ancillary equipment and tools may be useful to installers and maintenance personnel to aid in more sophisticated performance monitoring and testing. Table 7-16, Table 7-17, and Table 7-18 lists these items with recommended quantities per central office. Many of these items may already be a part of normal central office equipment.

Table 7-16. Miscellaneous Equipment and Tools

Description	COMCODE or Equipment Code	Minimum Quantities Recommended at CO	See Note	Qty. Ordered
Filter, Fan	ED-8C733-30,G4		10	
Tray, Fan (Spare Fan Pack)	ED-8C733-30,G6		11	
Front Cover Modification Kit, G3	847554177		14	
24G-U Assembly Kit	847851367		15	
24H-U Assembly Kit	848416269		16	
29G-U Assembly Kit	848345476		17	
29H-U Assembly Kit	848426607		18	
24G-U/24H-U/29G-U/29H-U Interconnect Cable Assembly	848102287			
Replacement User Panel for G3 or G4 Shelf	ED-8C724-31,G3			

* COMCODE not available at time of issue.

Table 7-17. Miscellaneous Fiber Cabling

Description	COMCODE or Equipment Code	Minimum Quantities Recommended at CO	See Note	Qty. Ordered
FS1EP-EP-2 Lightguide jumper *ST*® *II+-STII+* single-mode (SM) (2 ft.)	107149494	2	2,3	
FL1E-E-2 Lightguide jumper *ST-ST* multimode (MM) (2 ft.)	105351795	2	2,3	
Fiber optic cable *ST*-to-biconic (4 ft.)	105420913	2	8	
Fiber splitter w/*ST* connectors	407059047	1	13	
Fiber coupler w/*ST* connectors	105271142	2	13	
Fiber splitter w/FC connectors	407059054	1	13	
Fiber coupler w/FC connectors	Local supplier	2	13	
Fiber splitter w/SC connectors	407059062	1	13	
Fiber coupler w/SC connectors	106703200	2	13	
A3070D1 *ST* SM	107406191			
A3080D1 FC SM	107406233			
A2060D SC MM	106795289			
A2070D *ST* MM	106795321			

Table 7-18. Miscellaneous Accessories

Description	COMCODE or Equipment Code	Minimum Quantities Recommended at CO	See Note	Qty. Ordered
Craft interface terminal		1	1	
Strap, wrist > 6-1/2" circumference	408647824		4,5	
Terminal, ESD grounding	845264118		5	
Fuse, 5 amp (G1 shelf)	405697442		6	
Fuse, 5 amp (G3 and G4 shelf)	406203976		6	
Fuse extraction tool	406420273		6	
Modem			7	
Microduster Nozzle Assy with 10 oz. can, valve, and hose	406100321	1	9	
Microduster Air six 10 oz. refill cans	406852285		9	
Microduster Air twelve 10 oz. refill cans	406100339		9	
Absorbond Cleaner (Pkg.) or Equivalent	900709379	1	9	
Alcohol Squirt Bottle or Equivalent	900726464	1	9	
Lint-free Pipe Cleaners (Pkg.) or Equivalent	403780570	1	9	
Duct Notching Tool		1	12	

Notes on Table 7-16, Table 7-17, and Table 7-18:

1. A CIT is recommended for installation, maintenance, and administrative activities. A personal computer (PC) is required for software download and to run CPro-2000 software. The DDM-2000 OC-3 Multiplexer CIT port (mounted on the user panel) is a standard EIA-232-D (supersedes RS-232C specification) interface configured as DCE for direct connection to a CIT. The CIT port will support rates of 300, 1200, 2400, 4800, 9600, and 19,200 baud and should be compatible with most *ANSI* 3.64 ASCII terminals; however, it is optimized for standard CIT screens with display areas of 24 lines by 72 (or more) columns. A paging function is included in the DDM-2000 OC-3 Multiplexer to accommodate screen lengths from 3 lines to 150 lines.

   Those CITs compatible with DDM-1000 (see 363-206-100 for a list of DDM-1000 compatible terminals) should be directly compatible with the DDM-2000 OC-3 Multiplexer, although some may not be as convenient to use with the DDM-2000 OC-3 Multiplexer.

   If the multishelf bus cables (ED-8C724-20, G354 or G356) are connected between shelves in a bay, a CIT may then be connected to the user panel CIT port on any shelf and may address any other shelf in that bay (as well as the remote terminal shelves associated with that shelf in the bay). Any terminal compatible with the *ANSI* 3.64 standard should be compatible with the DDM-2000 OC-3 Multiplexer.

   See Section 11, "Technical Specifications" for PC specifications needed to run CPro-2000 software. The PC used for software download should have:

   - A minimum of 640K of random access memory (RAM)
   - *MS-DOS* * version 2.0 or newer
   - Hard disk
   - At least one floppy disk drive of 360K or larger capacity. Although the disk drive may accommodate either floppy or hard disk, a hard disk is preferred for its better performance. The disk requirement is met with most portable *MS-DOS* PCs with a single 3.5-inch disk. An *MS-DOS* PC with a hard disk and either a 3.5-inch 1.44M floppy disk may also be used.

2. Equipment noted is not required for normal maintenance routines but may be helpful for installation and troubleshooting testing.

3. Lightguide jumpers noted are 2-foot jumpers with *ST*® lightguide cable connectors that can be used for a manual optical loopback at the OLIU plug-in interface.

* Registered trademark of Microsoft Corporation.

4. It is recommended that one wrist strap be provided for each DDM-2000 OC-3 bay arrangement for protection against plug-in damage resulting from electrostatic discharge.

5. Each DDM-2000 OC-3 shelf comes equipped with an electrostatic discharge (ESD) jack on the front panel for ESD wrist straps (see Note 4). ESD grounding terminals may be also mounted miscellaneously in unused #12-24 tapped holes in typical bay framework. If rear access activities are anticipated, at least one of these terminals is recommended for rear access bay mounting.

6. The two –48 V feeders (A and B) required for each DDM-2000 OC-3 shelf are protected by 5-amp fuses that ship with the shelf. It is recommended that a supply of spare fuses be provided at DDM-2000 OC-3 Multiplexer locations. Fuses for the Group 1 shelf may be ordered through Lucent Technologies using COMCODE 405697442 or through Littlefuse, Inc., 800 East Northwest Highway, Des Plaines, IL 60016, or call 708-824-1188. Order: Fuse, 5-amp, Part No. 334005.

   Fuses and a fuse extraction tool for the Group 3 and Group 4 shelf may be ordered through Lucent using COMCODE 406203976 for fuses and COMCODE 406420273 for the extraction tool or through SAN-O Industrial Corporation, 91-3 Colin Drive, Sherwood Corporation Center, Holbrook, NY 11741 or by calling 516-472-6666 and ordering.
   Fuse, 5-amp, Part No. AX-1-5A or
   Fuse Extraction Tool, Part No. F-0431.

7. Where remote access is desired, an external modem may be furnished. Most manufacturers' modems should also be compatible. Two craft interface terminal ports are provided with each DDM-2000 OC-3 shelf which are compatible with the *ANSI* 3.64 ASCII EIA-232-D standard (supersedes RS-232C specification). The rear-access CIT port is configured as a data terminal equipment (DTE) to allow a permanent modem connection without requiring a null modem. Switch selected data rates of 300, 1200, 2400, 4800, 9600, and 19200 baud are available. When remote CIT capability is required, the modem interface cabling should be provided. One modem can serve up to six shelves (and their RT counterparts) in a bay arrangement.

8. Lightguide connectors at the OLIU plug-in interfaces are SC connectors. If interfaces for testing, etc., to biconic entities are required, the specified adapters or equivalent may be used. When using attenuator buildouts with universal connectors, the fiber must be the same on both sides of the attenuator to achieve the designated value. For example, if a single-mode (SM) jumper is used, the buildout must be SM and be on the transmit side; if a multimode (MM) jumper is used, the buildout must be MM and on the receive side.

9. It is very important that optical fiber connections be thoroughly cleaned whenever they are removed and reconnected to avoid potential service-affecting optical losses. Consult the TOP section of 363-206-202, 363-206-280, or 363-206-285, *DDM-2000 OC-3 Multiplexer User/Service Manual Volume II (TOP)* for cleaning procedures.

10. Fans are only required in cabinet applications and in uncontrolled environments. The fan filters must be replaced when air flow is reduced to a preset value. An alarm is automatically generated when that value is reached. While the time interval between filter changes is relative to the cleanliness of the local air, typical intervals for similar equipment in a CO environment is nine months. Filters are stocked and should be available in less than two weeks. It may be advisable to store spares at the location, perhaps 10 percent of the total number in use.

NOTE:
Do not rely on the filter alarm for filter replacement. A periodic maintenance program should be in place for the following reasons: 1) Some fans, i.e., cabinet fans, do not have filter sensors, 2) the sensor does not work when used in a multi-shelf configuration, and 3) the sensor unit is unreliable as an indicator of the filter condition.

11. The following shows recommendations for providing spare fan packs per number of fan shelves in service:

Fan shelves in service	15	48	93	143	198	258
Recommended spare fan packs	1	2	3	4	5	6

12. Order from PANDUIT Corporation, Tinley Park, Illinois.
Part number DNT-100.

13. A fiber splitter is required to perform the in-service point-to-point to ring upgrade. For other upgrades that may require the splitter, see the TOP section of the appropriate DDM-2000 OC-3 user/service manual. The splitter can be reused to support multiple in-service upgrades. Many commercial fiber splitters are available. The Models: 22-10131-50-13121 (w/*ST* connectors), 22-10131-50-13131 (w/FC connectors), and 22-10131-50-13141 (w/SC connectors) have been tested with the DDM-2000 and are recommended. For more information, contact Gould Fiber Optics, 6740 Baymeadow Drive, Glen Burnie, Maryland 21060. The customer service telephone number is 1-800-544-6853.

    Two fiber couplers are needed with the fiber splitters. Obtain the FC coupler from your local supplier.

14. Provides wider clearance between front cover and circuit pack faceplates. Required when 24G-U/24H-U, 29G-U/29H-U, or BBG19 are used in G3 shelf. Recommended when 27G-U/27G2-U is used.

15. Includes two 24G-U OLIUs and one Interconnect Cable Assembly. See Table 7-15 for ordering individual circuit packs.
16. Includes two 24H-U OLIUs and one Interconnect Cable Assembly. See Table 7-15 for ordering individual circuit packs.
17. Includes two 29G-U OLIUs and one Interconnect Cable Assembly. See Table 7-15 for ordering individual circuit packs.
18. Includes two 29H-U OLIUs and one Interconnect Cable Assembly. See Table 7-15 for ordering individual circuit packs.

Lightguide Jumpers

The DDM-2000 OC-3 lightguide interface uses both single-mode and multimode jumpers for connecting to and from the outside plant *LGX*® panel and the DDM-2000 OC-3.

When the outside plant lightguide is multimode, single-mode or multimode jumpers can be used between the *LGX* panel and the DDM-2000 OC-3 on the transmit (OUT) side and multimode must be used on the receive (IN) side of all optical line interface units (OLIUs) except the 21D/21D-U and 22D-U OLIUs.

When the outside plant lightguide is single-mode, single-mode jumpers must be used for the transmit side and either single-mode or multimode jumpers can be used for the receive side of all OLIUs except the 21D/21D-U and 22D-U OLIUs.

The 21D/21D-U and 22D-U OLIUs, used for intershelf OC-3/OC-12 interconnection, must use multimode jumpers on both transmit and receive sides.

The OC-1 lightguide interface uses single-mode jumpers for connecting to and from the DDM-2000 FiberReach Multiplexer.

Single-mode jumpers are listed in Table 7-19. Multimode jumpers are listed in Table 7-20. For other types of lightguide jumpers contact your Lucent Technologies Account Executive.

Table 7-19. Single-Mode Lightguide Jumpers

Code	Comcode	Description	Length (Feet)	Connectors
FS1EP-EP-2	107149494	Lightguide Jumper	2	*ST®II+-STII+*
FS1EP-EP-10	107149536	Lightguide Jumper	10	*STII+-STII+*
FS1EP-EP-25	107149569	Lightguide Jumper	25	*STII+-STII+*
FS1EP-EP-50	107149601	Lightguide Jumper	50	*STII+-STII+*
FS1EP-EP-100	107149627	Lightguide Jumper	100	*STII+-STII+*
FS1E-A-2	105420905	Lightguide Jumper	2	*ST*-2016A Biconic
FS1E-A-10	105420947	Lightguide Jumper	10	*ST*-2016A Biconic
FS1E-A-25	105423958	Lightguide Jumper	25	*ST*-2016A Biconic
FS1E-A-50	105424006	Lightguide Jumper	50	*ST*-2016A Biconic
FS1E-A-100	105424022	Lightguide Jumper	100	*ST*-2016A Biconic
LS1SC-SC-2	106908247	Lightguide Jumper	2	SC-SC
LS1SC-SC-10	106908270	Lightguide Jumper	10	SC-SC
LS1SC-SC-25	106908304	Lightguide Jumper	25	SC-SC
LS1SC-SC-50	106908346	Lightguide Jumper	50	SC-SC
LS1SC-SC-100	106908395	Lightguide Jumper	100	SC-SC
LS1FP-FP-10	106593825	Lightguide Jumper	10	FCPC-FCPC
LS1FP-FP-25	106932908	Lightguide Jumper	25	FCPC-FCPC
LS1FP-FP-50	106932916	Lightguide Jumper	50	FCPC-FCPC
LS1FP-FP-100	106932924	Lightguide Jumper	100	FCPC-FCPC

Table 7-20. Multimode Lightguide Jumpers

Code	Comcode	Description	Length (Feet)	Connectors
FL1-E-2	105351795	Lightguide Jumper	2	*ST*®-ST
FL1-EP-EP-04	107150161	Lightguide Jumper	4	*ST® II+-STII+*
FL1-EP-EP-10	107150195	Lightguide Jumper	10	*STII+-STII+*
FL1-EP-EP-25	107150229	Lightguide Jumper	25	*STII+-STII+*
FL1-EP-EP-50	107150260	Lightguide Jumper	50	*STII+-STII+*
FL1-EP-EP-100	107150286	Lightguide Jumper	100	*STII+-STII+*
FL1E-A-2	105613954	Lightguide Jumper	2	*ST*-2016A Biconic
FL1E-A-10	105613988	Lightguide Jumper	10	*ST*-2016A Biconic
FL1E-A-25	105614010	Lightguide Jumper	25	*ST*-2016A Biconic
FL1E-A-50	105614051	Lightguide Jumper	50	*ST*-2016A Biconic
FL1E-A-100	105614119	Lightguide Jumper	100	*ST*-2016A Biconic
LL1SC-SC-2	106908668	Lightguide Jumper	2	SC-SC
LL1SC-SC-10	106908692	Lightguide Jumper	10	SC-SC
LL1SC-SC-25	106908734	Lightguide Jumper	25	SC-SC
LL1SC-SC-50	106908775	Lightguide Jumper	50	SC-SC
LL1SC-SC-100	10690879	Lightguide Jumper	100	SC-SC
LL1FC-FC-10	107095549	Lightguide Jumper	10	FC-FC
LL1FC-FC-25	107095556	Lightguide Jumper	25	FC-FC
LL1FC-FC-50	107095564	Lightguide Jumper	50	FC-FC
LL1FC-FC-100	107095572	Lightguide Jumper	100	FC-FC

In-Line Attenuators

Table 7-21 lists the in-line attenuators.

Table 7-21. In-Line Attenuators

Product Code	Connection Type	Connector Type	Attenuation (dB) at 1300 nm	Comcode
502A	MM-MM	Biconic	5.0 ±1	105 347 827
502B	MM-MM	Biconic	7.0 ±1	105 347 835
502C	MM-MM	Biconic	9.0 ±1	105 347 843
602A	SM-MM	Biconic	3.0 ±1	105 167 803
602B	SM-MM	Biconic	5.0 ±1	105 167 845
602C	SM-MM	Biconic	7.0 ±1	105 167 894
702A	SM-SM	Biconic	2.5 ±.05	105 347 884
702B	SM-SM	Biconic	5.0 ±.05	105 347 892
702C	SM-SM	Biconic	7.5 ±.05	105 347 900
A2000B	MM-MM	*ST*	5.0	106 597 297
A2000D	MM-MM	*ST*	10.0	106 597 446
A3000B	SM-SM	*ST*	5.0	106 060 718
A3000D	SM-SM	*ST*	10.0	106 060 734

OC-12 Ordering

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OC-12 Ordering

8

Overview

This section provides equipment ordering information for the DDM-2000 OC-12 Multiplexer and OC-12 Regenerator.

Record of Changes

Changes are with respect to the previous version of this document, 363-206-200, Issue 9, dated October 1999, and includes changes related to new cable ordering. These changes include:

- Added information for new cable groups
- Updated references to cable drawings (TOCs, new figure references).

Introduction

This section is designed to facilitate the equipment engineer when issuing a telephone equipment order (TEO). It is not intended to replace standard engineering documentation; for example, schematic drawings, equipment drawings, etc. Although this section is not required as a part of a DDM-2000 OC-12 Multiplexer order, if this section is used, it will help to ensure that all elements of the DDM-2000 OC-12 Multiplexer and related interfaces arrive on time and are installed on schedule to assure the timely turnup of DDM-2000 OC-12 equipment.

This section has four major tabs covering ordering information for DDM-2000 OC-12 Multiplexer shelves and cabling (OC-12 Ordering tab), software (Software Ordering tab), plug-ins (Plug-Ins tab), and miscellaneous equipment and tools (Miscellaneous Equipment and Tools tab).

This section covers ordering information for a single DDM-2000 OC-12 Multiplexer shelf assembly, multiple DDM-2000 OC-12 shelf assemblies for bay arrangements, intershelf cabling, plug-ins, and miscellaneous equipment and tools. See Section 7, "OC-3 Ordering," for information on combined DDM-2000 OC3 and OC-12 arrangements.

Although each shelf is ordered separately and may be mounted as a stand-alone or miscellaneous mount item, suggested typical bay arrangements are provided per ED-8C727-10 that give complete engineering information that fits traditional central office design criteria. For combined DDM-2000 OC-3/OC-12 typical bay arrangements, see ED-8C724-10 and the DDM-2000 OC-3 Ordering section in this document.

The DDM-2000 OC-12 shelf is completely connectorized. Therefore, when bay cabling is installed on an initial order, additional shelves can be installed by local technicians without the need for installation forces, and costs can be deferred to a point just prior to service needs. Since shelves, standardized cable assemblies and plug-ins are stocked at Lucent material distribution centers (MDC), order turnaround is substantially reduced for most common arrangements.

Fuses for the –48 volt A and B feeders are provided on the user panel of the DDM-2000 shelf assemblies. The feeders are fused at 5 A for OC-3 and 10 A for OC-12.

Completing an Order Blank

Complete the appropriate order blank:

- Shelf Order Blank
- Appropriate Cable Order Blanks
- Plug-In Order Blank
- Miscellaneous Equipment and Tools Table.

Shelf and Cable Ordering

Single Shelf Order Blank, Table 8-1, Page 8-6
OC-12 Rear Access Cabling, Figures Figure 8-1-1 through Figure 8-1-13
OC-12 Rear Access Order Blanks, Pages 8-22 through 8-25
OC-12 Front Access Cabling, Figures 8-2-1 through 8-2-13
OC-12 Front Access Order Blanks, Pages 8-43 through 8-49

Software Ordering

OC-12 Discontinued Available (DA) SW,Table 8-3, Page 8-53
OC-12 Software Ordering, Table 8-2, Page 8-51
OC-12 Application Summary Matrix, Table 8-4, Page 8-54

OC-12 Plug-Ins

OC-12 Plug-In Order Blank, Table 8-11, Page 8-71

Miscellaneous Equipment and Tools

Miscellaneous Equipment and Tools, Table 8-13, Page 8-73
Miscellaneous Fiber Cabling, Table 8-14, Page 8-74
Miscellaneous Accessories, Table 8-15, Page 8-75

These blanks may be reproduced for order placement. This section requires the entering of quantities or other data needed to assist in engineering the job. Only those blanks pertaining to this particular order should be attached to the order sheet (tables and cable order blanks).

Shelf and Cable Ordering

DDM-2000 OC-12 Shelf Assembly, ED-8C727-30, G4 Ordering

A single DDM-2000 OC-12 shelf assembly, ED-8C727-30, G4, and fan assembly, ED-8C733-30, G8, are all that is required to accommodate many different network applications. The OC-12 shelf assembly supports OC-3 optical low speed interfaces, DS3 low speed interfaces, EC-1 low-speed interfaces, and OC-12 optical high speed interfaces. Additional features will be available in the future through the simple addition of new plug-ins or software without the need for shelf modifications. Some of these future bay arrangements may require new or changed cabling interfaces. If future plans are known, it may be advantageous to order this cabling with the initial order to facilitate later installations.

The Group 4 shelf will be available in the third quarter of 1997, replacing the Group 1 shelf for new applications. The Group 4 shelf can replace the Group 1 shelf in all applications. When using the G4 shelf with the alternative isolated grounding scheme, the BBG8B SYSCTL is required. The G4 shelf may be used with a traditional grounding scheme with any system controller circuit pack.

If desired, a G1 shelf can be upgraded to provide the deeper front cover offered with the G4 shelf by ordering the Front Cover Upgrade Kit, comcode #847554185.

The fan assembly must be located above the shelf as described in ED-8C727-10, with a minimum 3-inch air space below the shelf. If you plan to structure DDM-2000 OC-12 shelves in bay arrangements, additional information will be required for shelf placement.

DDM-2000 OC-12 ED-8C727-30, G4 Shelf Orders for Central Office Bay Arrangements

Although DDM-2000 OC-12 shelves are normally ordered as stand-alone entities along with an ED-8C733-30 fan shelf, typical bay arrangements can be locally engineered or pre-configured and installed per Figure 7-3-2 and 7-4-2 or per the OC-3 Ordering section for combined OC-3/OC-12 bays (ED-8C906-30, G3 & G4 [four OC-3 / one OC-12]). Refer to Figure 6-49, Page 6-98 and Table 7-2, Page 7-9 for more information.

Typical Bay Arrangement for DDM-2000 OC-12 Optical Networks

Figure 8-1-2 provides a typical bay arrangement (ED-8C727-10) for up to three OC-12 SONET configured shelves. This arrangement meets network equipment-building system (NEBS) central office requirements for bay heat dissipation. Although additional space is available in the bay, it should not be used for miscellaneous equipment if the NEBS requirements are to be met. In addition, if other than the typical arrangements are used, normal heat flow could be interrupted and adversely affect shelf operation. Heat baffles, fan shelf, and air gaps must be placed as indicated to guarantee proper air circulation. Although the typical bay figures reflect 7-ft. bay arrangements, 9-ft. or 11-ft. 6-in. bays may be used, providing the shelf arrangements are identical to those shown for the 7-ft. arrangements.

As mentioned previously, shelves can be added incrementally by local technicians (since all cabling is connectorized) providing that interbay cabling is initially provided for the bay layout. If shelves are incrementally installed, it is recommended that they be installed in position number sequence as shown in Figure 8-1-2 to simplify bay mult cabling. However, shelves may be added in any position if proper bay mult cabling is selected. There is one exception. The first shelf installed should be installed in Position 1. Also, if using parallel telemetry, shelf ID administration could be a problem if shelves are not added sequentially.

Table 8-1. OC-12 Shelf Order Blank

(Provide one blank per shelf ordered)

Qty Ord	Equipment Code	Equipment Furnished with Group Ordered					Description
		Shelf	Shelf w/Manual	Heat Baffle	Fan Assy	See Note	
	ED-8C727-30, G4	1				1	DDM-2000 OC-12 Shelf
	ED-8C727-30, G4, A		1			1,2	DDM-2000 OC-12 Shelf
	ED-8C727-30, G4, D		1			1,3,7	DDM-2000 OC-12 Shelf
	ED-8C727-30, G4, E	1				1,4,7	DDM-2000 OC-12 Shelf
	ED-8C733-30, G1			1		5	Baffle
	ED-8C733-30, G8				1	5	Fan Assembly
	847554185					6	OC-12 G1 Front Cover Upgrade Kit

Notes:

1. See Plug-Ins tab for examples of shelf plug-in arrangements. Included with each ED-8C727-30, G1 or G4 shelf is hardware required for bay mounting.
2. Equipment Code A adds an *363-206-207, DDM-2000 OC-12 Multiplexer And OC-12 Regenerator User/Service Manual* for Releases through R3.x.x. The user/service manual can also be ordered using the software ordering blank in the "Software Ordering" section.
3. Equipment Code D adds an *363-206-290, DDM-2000 OC-12 Multiplexer And OC-12 Regenerator User/Service Manual* for Releases R5.0, R5.1, and R5.2. The user/service manual can also be ordered using the software ordering blank in the "Software Ordering" section.
4. Equipment Code E adds an *363-206-295, DDM-2000 OC-12 Multiplexer And OC-12 Regenerator User/Service Manual* for Releases R7.0. The user/service manual can also be ordered using the software ordering blank in the "Software Ordering" section.
5. A heat baffle assembly should be ordered with each shelf assembly except for the top shelf in a 7-ft. bay arrangement. When the 7-ft. layout is mounted in 9-ft. or 11-ft. 6-in. bays, a baffle should also be ordered for the top shelf. See ED-8C727-10 for complete bay assembly information.
6. This upgrade kit primarily provides a deeper cover to the OC-12 ED8C727-30 G1 shelf to better accommodate the fiber optic cables when alternative optical connectors (FC/PC/SC) are used. Available in third quarter 1997.
7. The ED-8C727-30, G4 shelf will replace the ED8C727-30, G1 shelf once it becomes available and the G1 shelf will be rated Discontinued Availability.

DDM-2000 OC-12 Rear Access Cabling

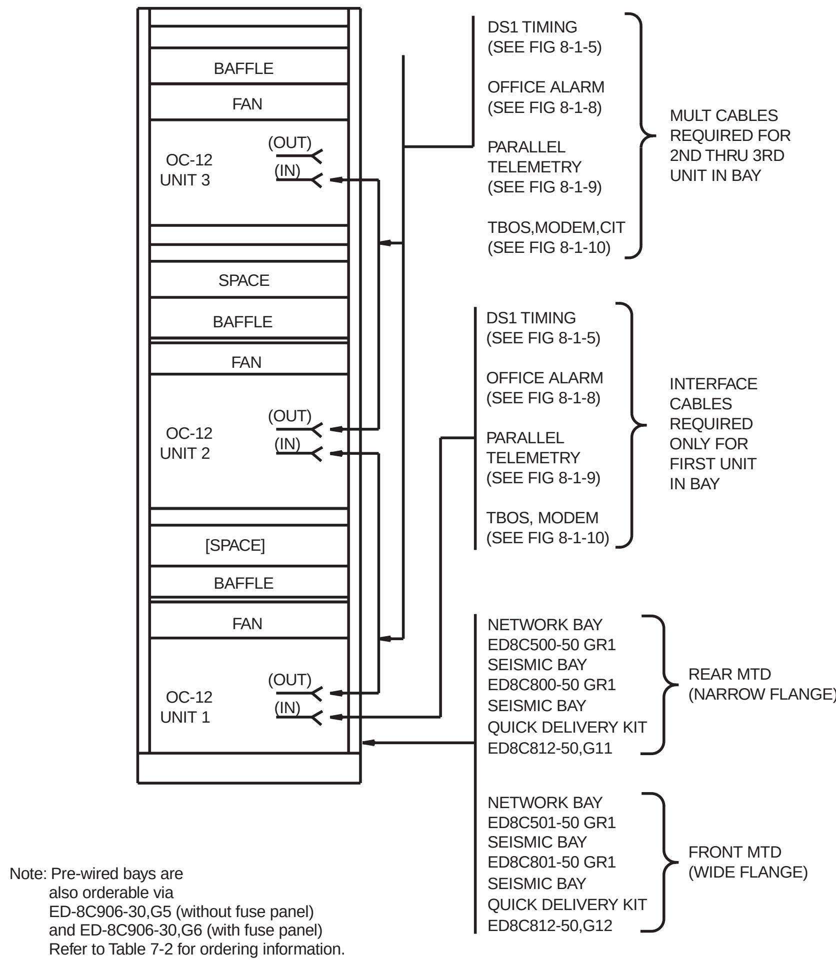

Figure 8-1-1 Typical Bay Arrangement for DDM-2000 OC-12, Rear Access

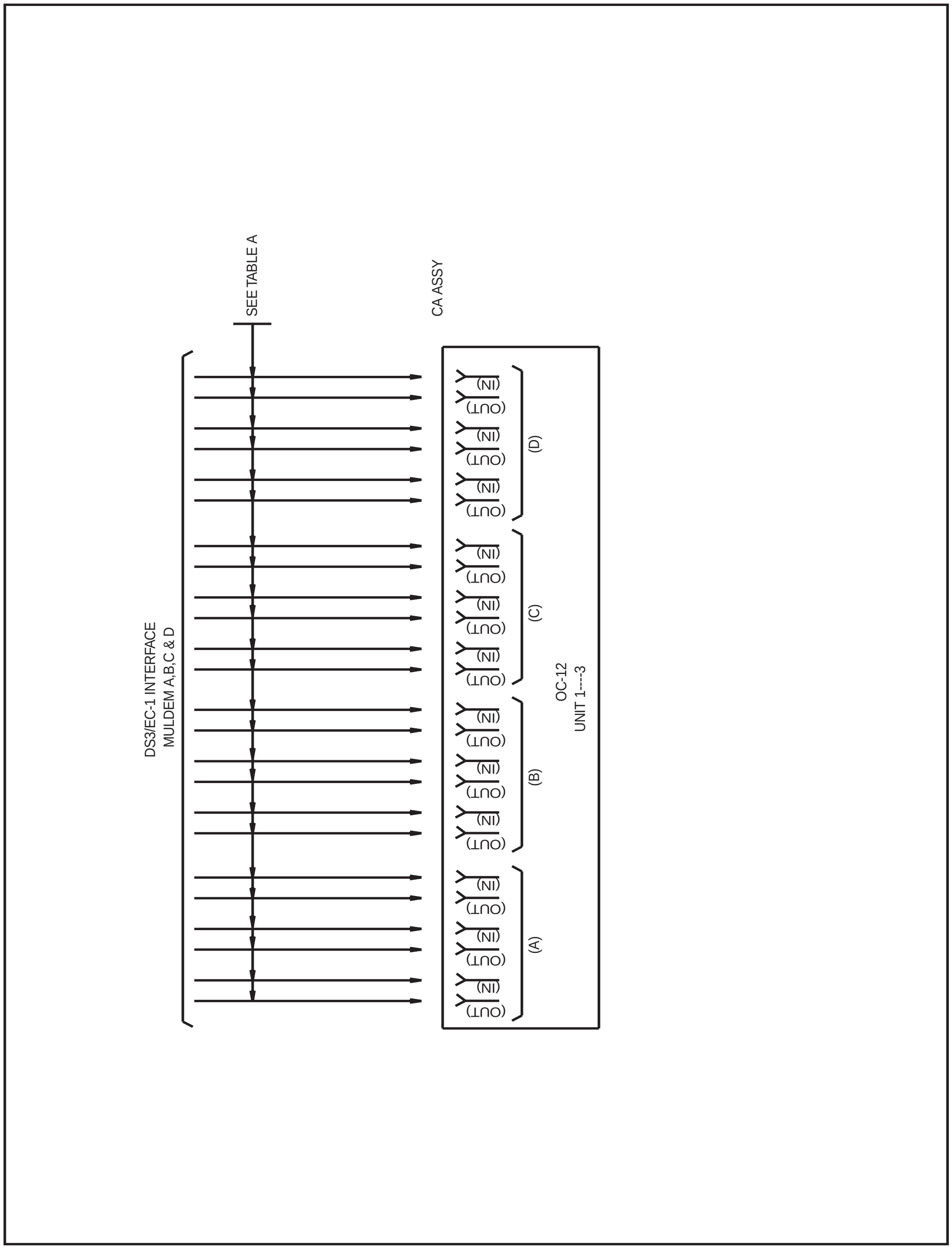

Figure 8-1-2 DS3/EC-1 Transmission Cable

TABLE A (OC-12 COAXIAL CABLE APPLICATIONS FOR REAR ACCESS CABLING)

APPLICATION		CABLE TYPE****	ED8C900-12 *	MAXIMUM LENGTH	REMARKS
DSX-3,DSX 3/4, STSX-1		735A (BNC-BNC)†		250 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		250 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
DACS III-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC)†		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821AE-BNC)‡		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (9821AE-BNC)‡		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D-735A (9821AE-BNC)‡		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
DACS IV-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC)†		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821EA-BNC) ‡ (OUT)		500 FT MAX	THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		735A (9821FA-BNC) ‡ (IN)			THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		1735006A (9821EA/FA-BNC)‡		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF**
		735A 734D 735A (9821EA-BNC) ‡ (OUT)		900 FT MAX	THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		735A 734D 735A (9821FA-BNC) ‡ (IN)			THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF

* ED-8C900-12 HAS REPLACED ED-8C900-20 FOR ALL DS3/EC-1 ORDERING.
CABLES IN THIS DRAWING ARE SORTED BY CONNECTOR TYPES.
** - EACH 1735006A CABLE CONTAINS 6 COAXIAL CABLES WITH ASSOCIATED CONNECTORS.
*** - THE G( ), DBD, 1LA CONSISTS OF A SHORT LENGTH OF 735A CABLE SPLICED TO 734D CABLE. THIS GROUP ALLOWS EASIER CONNECTION TO THE OC-12.
THE G( ), DB, 1LA MAY BE USED BUT IS NOT RECOMMENDED DUE TO THE PHYSICAL CONGESTION ON THE OC-12 BACKPLANE.
†- STRAIGHT AND RIGHT ANGEL
‡ - RIGHT ANGLE ONLY

Figure 8-1-3 DS3/EC-1 Transmission Cable

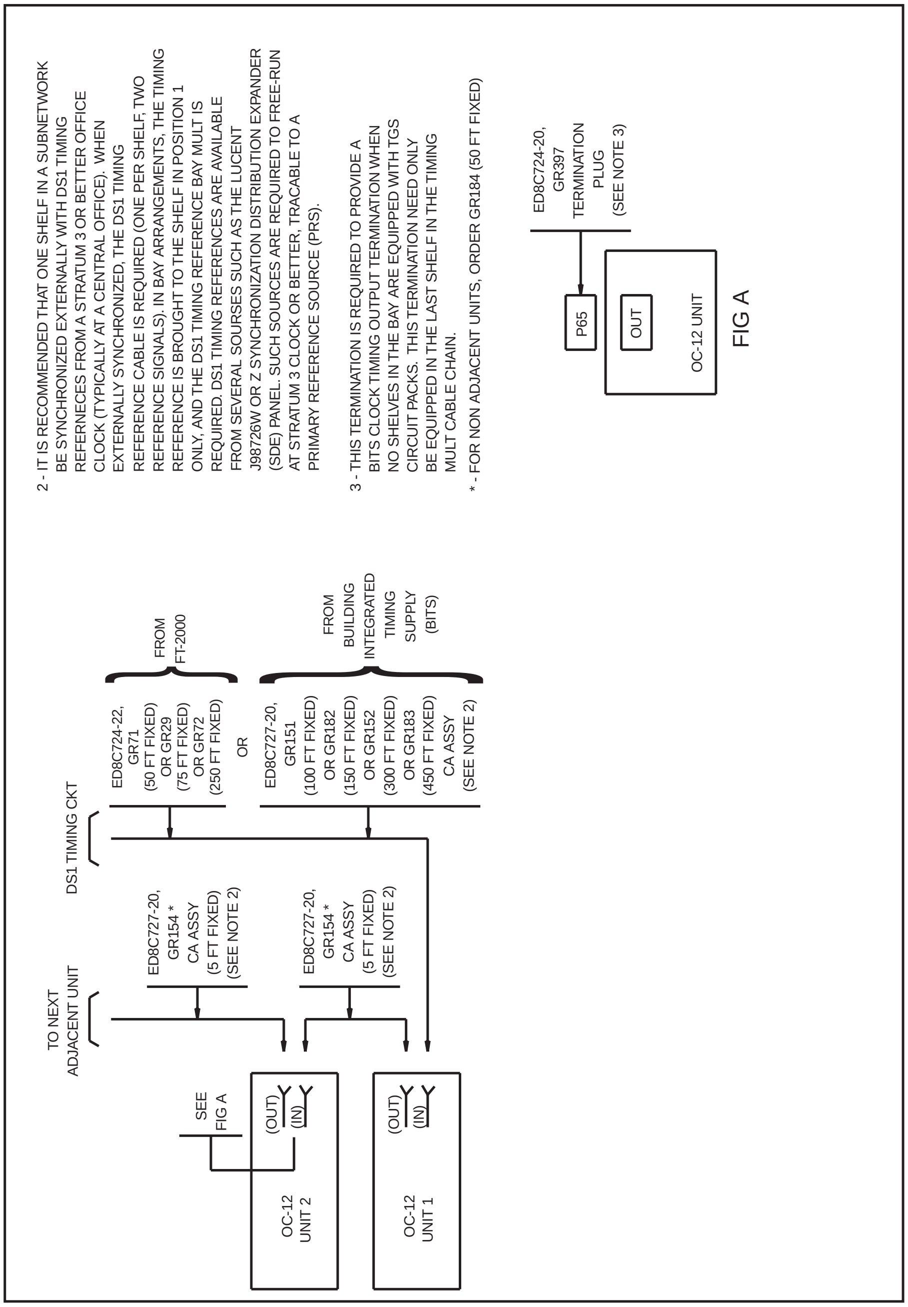

Figure 8-1-4 DS1 Timing Reference Interface and Mult Cable

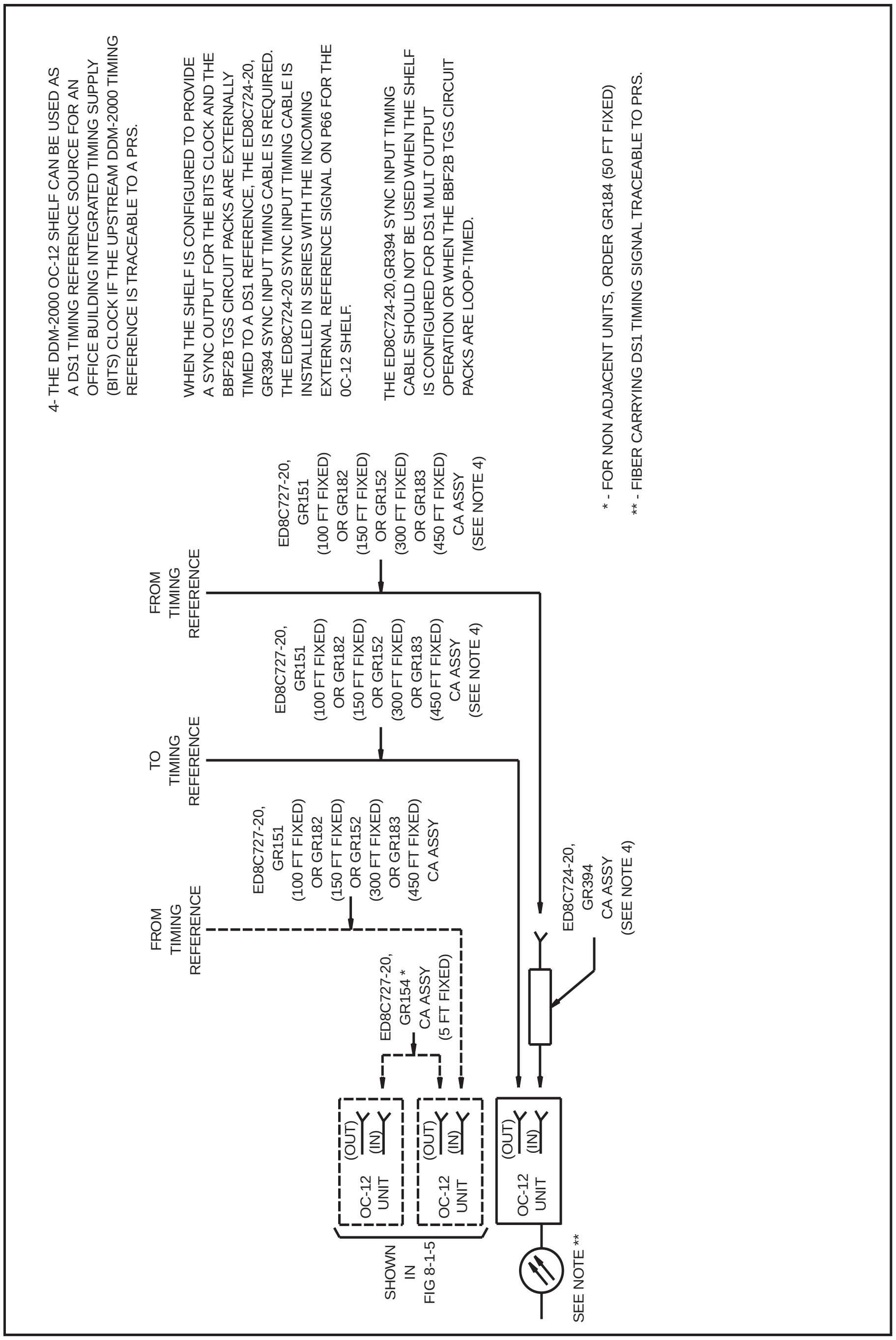

Figure 8-1-5 Synchronization for Timing Distribution Cable in a Bay Arrangement

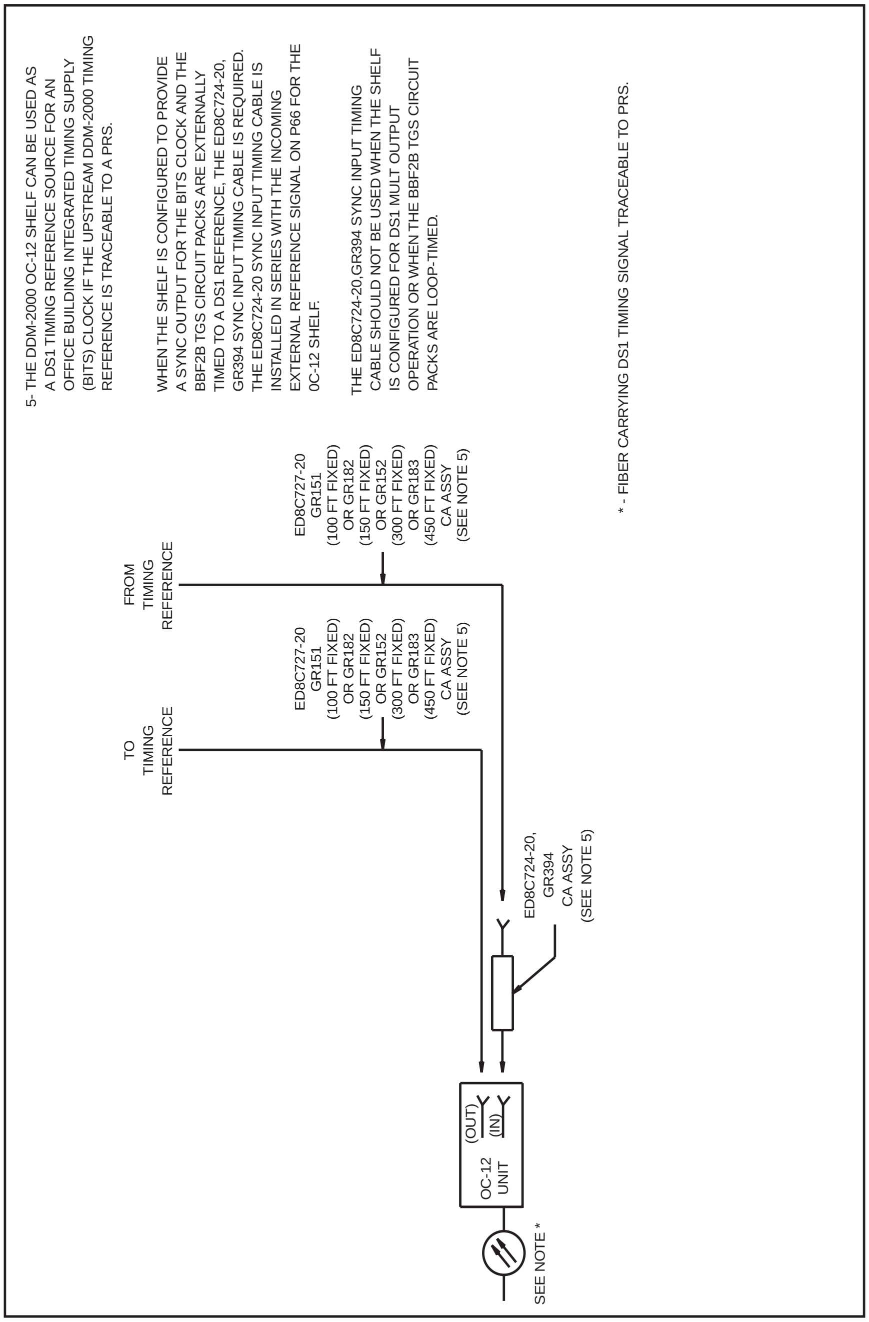

Figure 8-1-6 Synchronization for Timing Distribution Cable in a Single Shelf Assembly

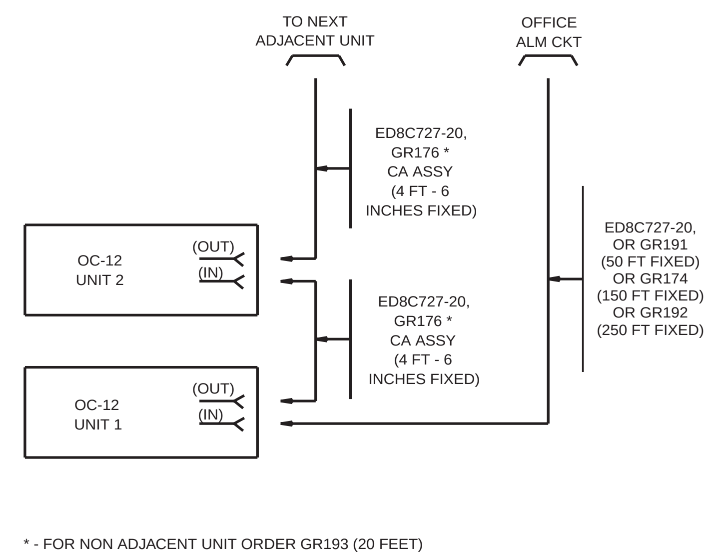

Figure 8-1-7 Office Alarm Interface and Mult Cable

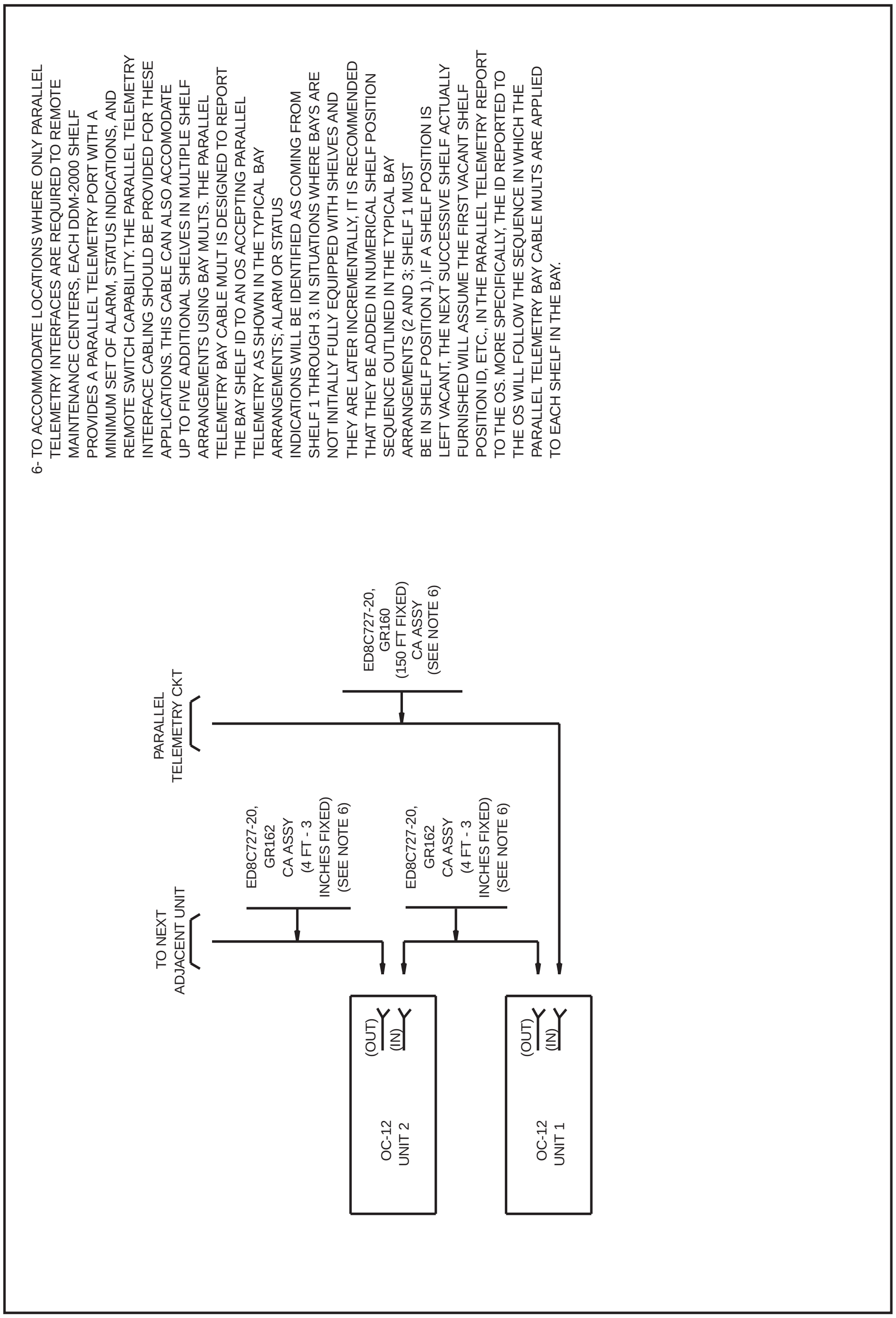

Figure 8-1-8 Parallel Telemetry Interface and Mult Cable

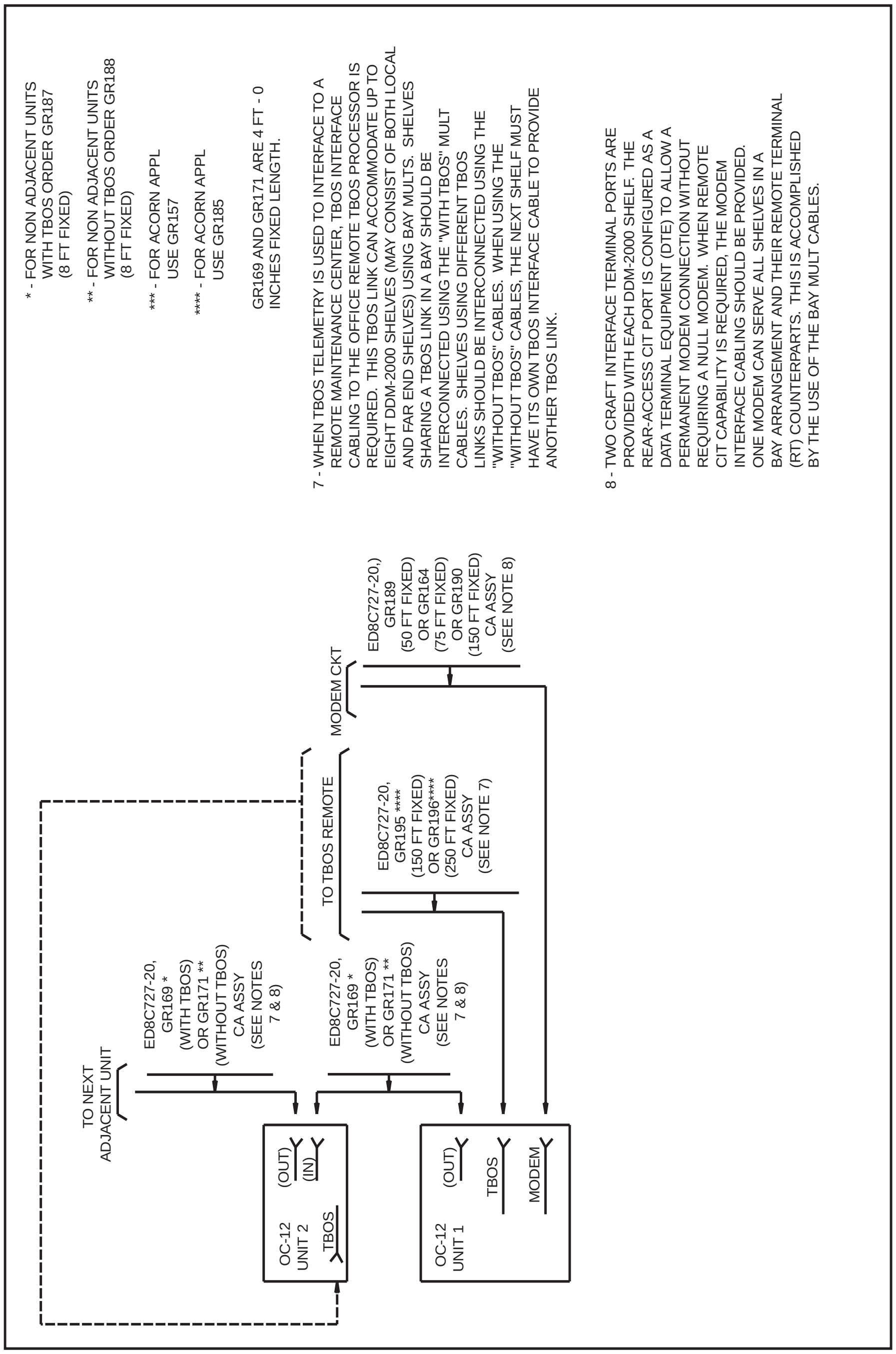

Figure 8-1-9 Modem, TBOS Interface, and Bay Mult Cable for TBOS, CIT, and Modem

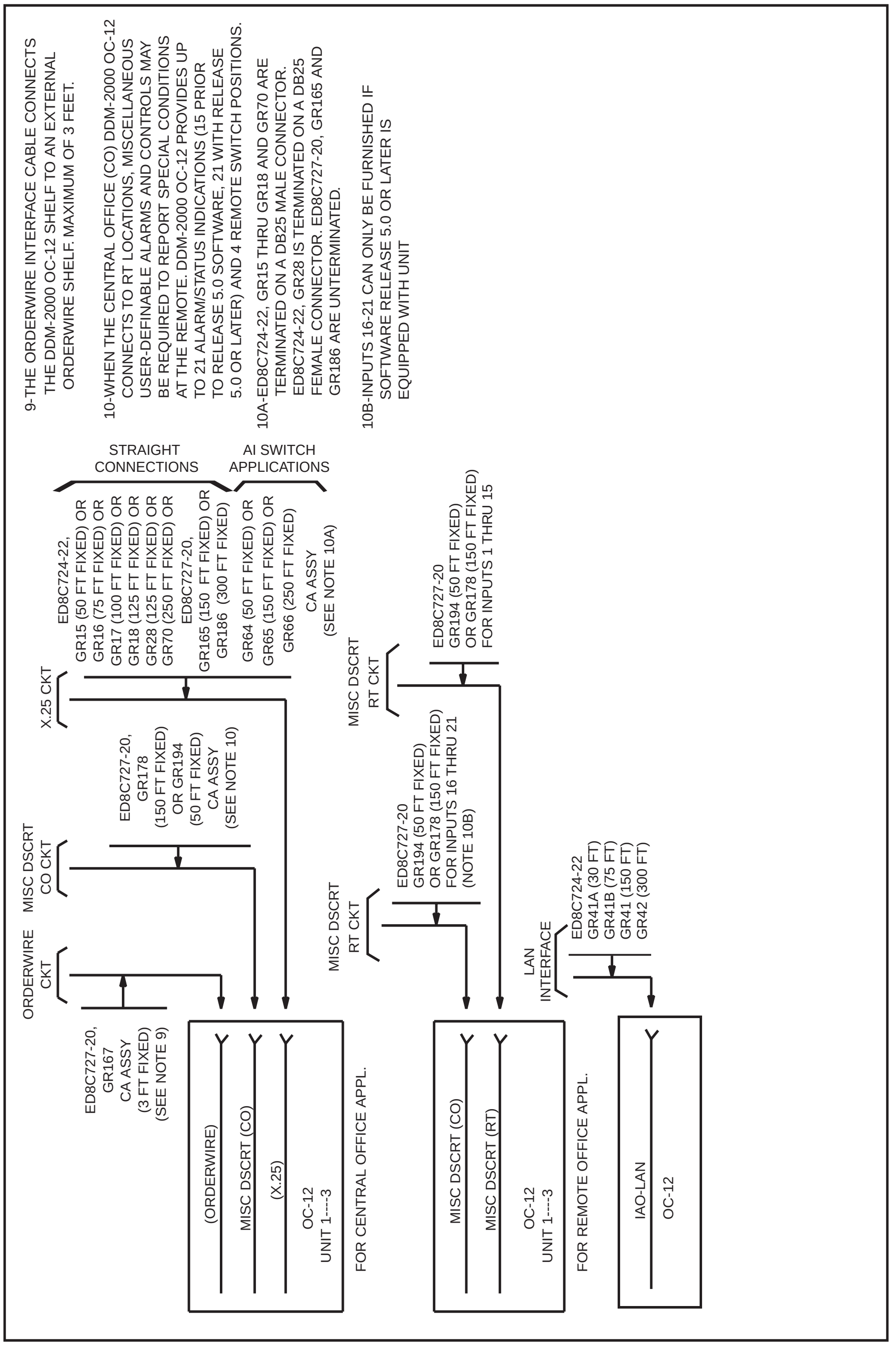

Figure 8-1-10 X.25 Interface, Miscellaneous Discretes, Order Wire, and LAN

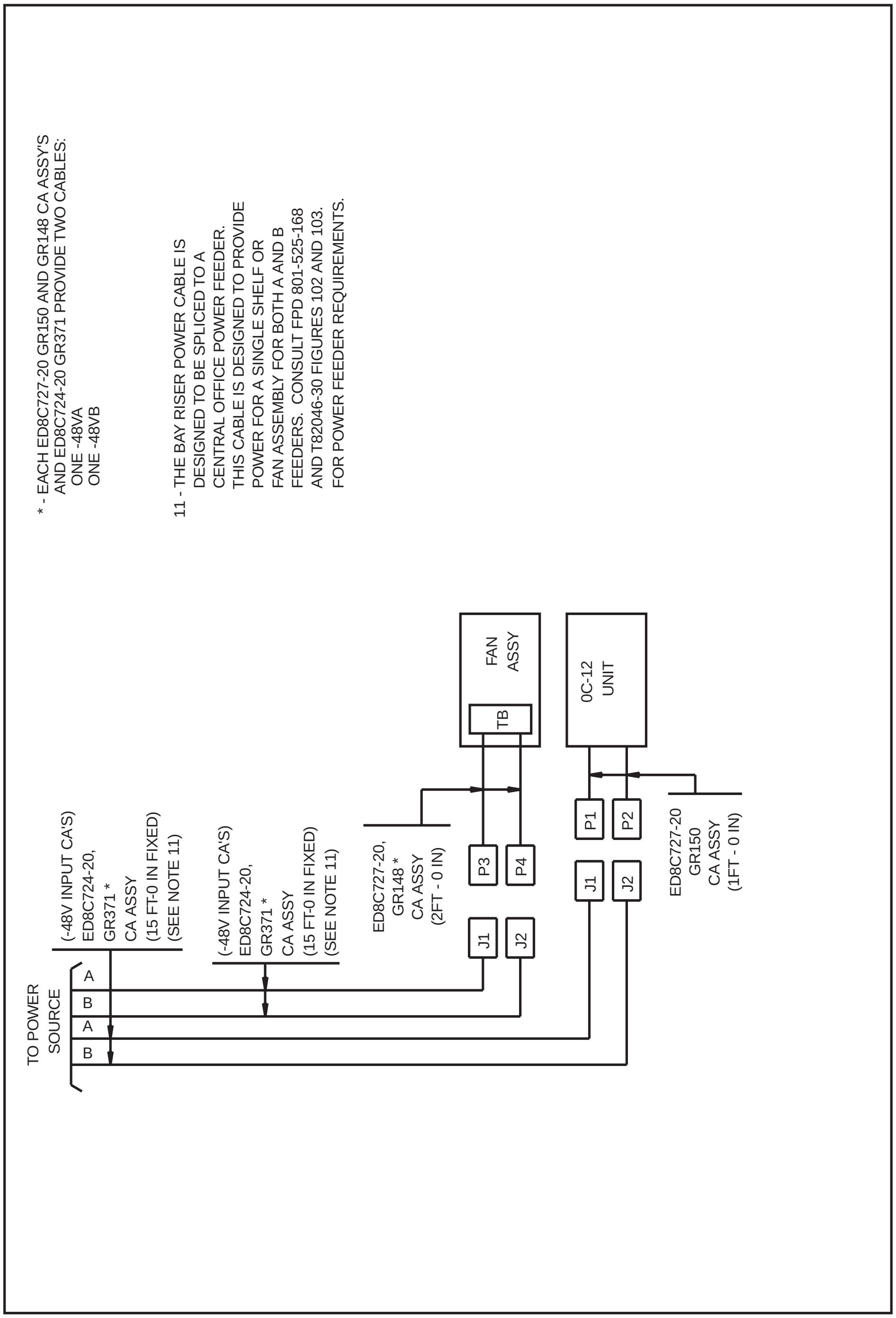

Figure 8-1-11 Power for Single OC-12 Unit and Fan Assembly

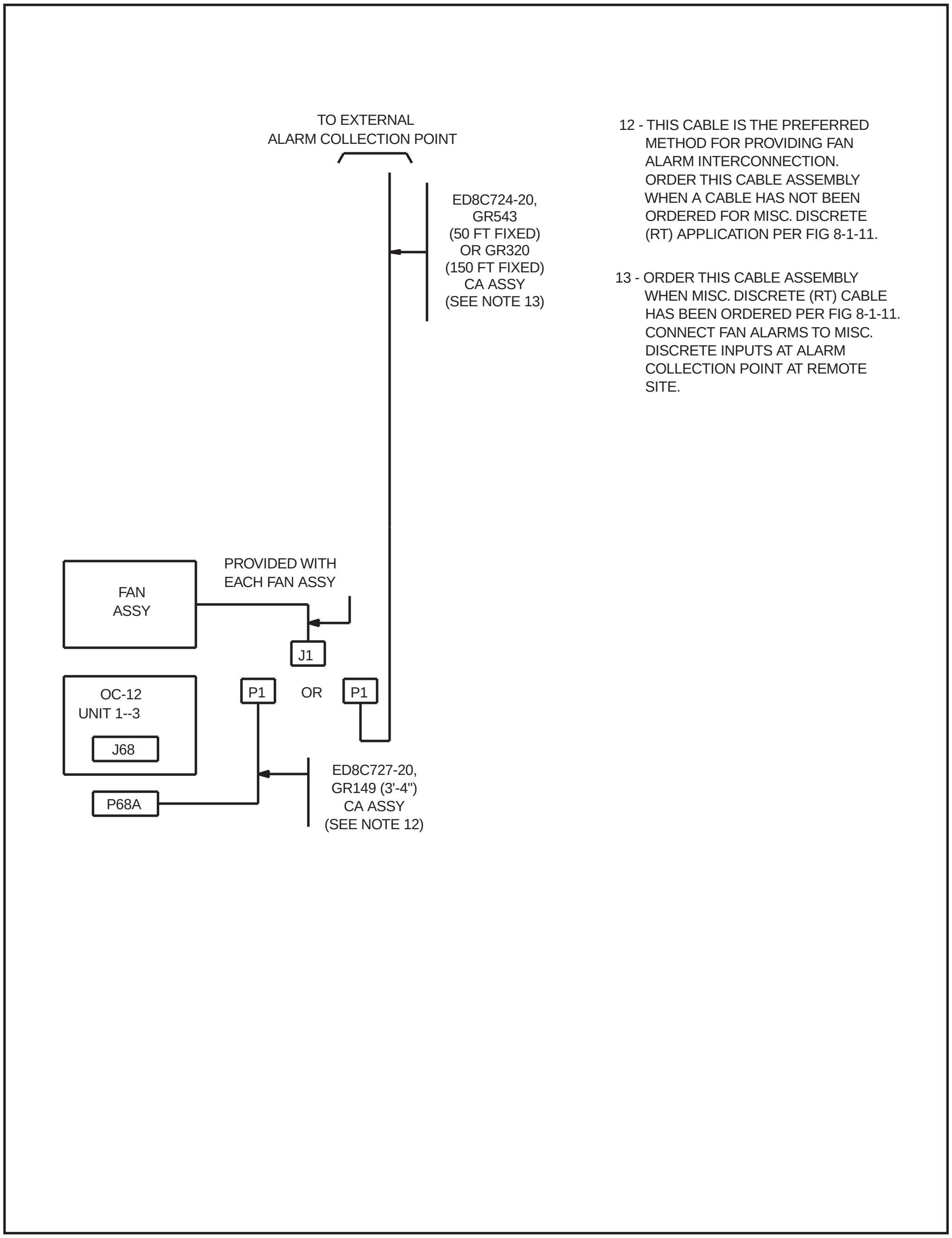

Figure 8-1-12 Cable Assembly for Fan Alarm

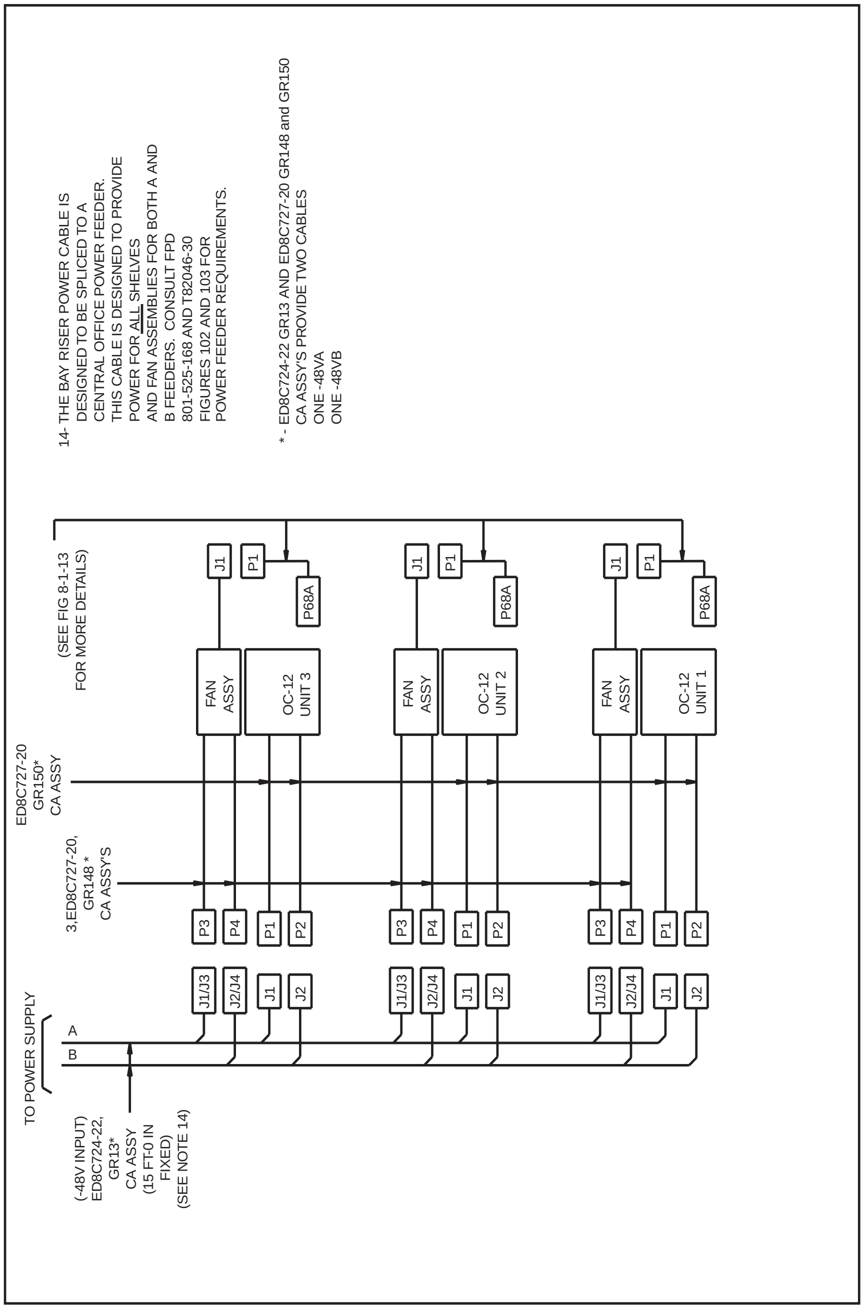

Figure 8-1-13 Power Input Cable for Bay Arrangement of OC-12 Rear Access Units With Fan Assembly

OC-12 REAR ACCESS CABLE ORDER BLANK (SHEET 1 OF 4)

Fig. Description	Fig.	Code	Group/Comcode Num	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
735A Cable for DS3/EC-1 Applications When Wiring Each MULDEM on an Individual Basis	8-1-2/ 8-1-3	ED8C900-12	108799651* (Table 1V)	150	24	24		Note 1 Six Groups (cables) Required per MULDEM
1735006A Cable for DS3/EC-1 Applications When All Three MULDEMS are Wired at the Same Time	8-1-2/ 8-1-3	ED8C900-12	108811845* (Table 4V)	150	4	4		Note 1 One Group per MULDEM
734D Cable for DS3/EC-1 Applications When Cable Length Exceeds the 735A Type Cable Requirements	8-1-2/ 8-1-3	ED8C900-12	108817800** (Table 6G)	150	24	24		Notes 1 and 3 Six Groups (cables) Required per MULDEM

* Right angle BNC — loose straight BNC.
** Straight BNC — no connector.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

Note 3: One end has no connector. Order ED-7C001-23 G604 13-foot pigtail equipped with right-angle BNC.

OC-12 REAR ACCESS CABLE ORDER BLANK (SHEET 2 OF 4)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
DS1 Timing Input and MULT Cable Required Between Adjacent Units	8-1-4	ED8C724-22	29 or	75	1			From FT-2000
	8-1-4		71 or	50				
	8-1-4		72	250				
	8-1-4	ED8C727-20	151 or	100				From BITS
	8-1-4		152 or	300				
	8-1-4		182 or	150				
	8-1-4		183	450				
	8-1-4	ED8C727-20	154 or			1		
	8-1-4		184	50				For Nonadjacent Unit
	8-1-4	ED8C724-20	397			A/R		See Fig. 8-1-5, Fig. A
Synchronization for Timing Distribution Cable in a Bay Arrangement	8-1-5	ED8C727-20	151 or	100	1	A/R		As Required Per Fig. 8-1-5
	8-1-5		152 or	300				
	8-1-5		182 or	150				
	8-1-5		183	450				
	8-1-5	ED8C724-20	394		1			
	8-1-5	ED8C727-20	154 or			See Note		As Required per Fig. 8-1-5
	8-1-5		184	50				For Nonadjacent Unit
	8-1-5	ED8C724-20	397			A/R		See Fig. 8-1-5, Fig. A
Synchronization for Timing Distribution Cable in a Single Shelf Assembly	8-1-6	ED8C727-20	151 or	100	2			
	8-1-6		152 or	300				
	8-1-6		182 or	150				
	8-1-6		183	450				
	8-1-6	ED8C724-20	394		1			
Office Alarm Interface and MULT Cable Required Between Adjacent Units	8-1-7	ED8C727-20	174 or	150	1			
	8-1-7		191 or	50				
	8-1-7		192	250				
	8-1-7		176 or			1		
	8-1-7		193	20				For Nonadjacent Units
Parallel Telemetry Interface and MULT Cable Required Between Adjacent Units	8-1-8	ED8C727-20	160	150	1			
	8-1-8		162			1		

OC-12 REAR ACCESS CABLE ORDER BLANK (SHEET 3 OF 4)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes	
Modem, TBOS Interface and MULT Cable for TBOS and Bay MULT Wiring Between Adjacent Units	8-1-9	ED8C727-20	164 or	75	1			Modem	
	8-1-9		189 or	50					
	8-1-9		190	150					
	8-1-9		157 or	150	1	A/R		TBOS	For (AT&T) ACORN Applications
	8-1-9		185 or	300					
	8-1-9	ED8C727-20	195 or	150					For Non-ACORN Applications
	8-1-9		196	250					
	8-1-9		169 or			1		With TBOS	
	8-1-9		171 or					Without TBOS	
	8-1-9		187 or	8				For Nonadjacent Units With TBOS	
	8-1-9		188	8				For Nonadjacent Units Without TBOS	

OC-12 REAR ACCESS CABLE ORDER BLANK (SHEET 4 OF 4)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes	
X.25 Interface, Miscellaneous Discretes, Orderwire, and IAO LAN Cables as Required for each OC-12 Unit	8-1-10	ED8C727-20	165 or	150	1	1		X.25	Unterminated
	8-1-10		186 or	300					
	8-1-10	ED8C724-22	15 or	50					Terminated on Male Connector
	8-1-10		16 or	75					
	8-1-10		17 or	100					
	8-1-10		18 or	125					
	8-1-10		70 or	250					
	8-1-10		28	125					Term. on Female Conn.
	8-1-10		64	50					AI Switch
	8-1-10		65	150					
	8-1-10		66	250					
	8-1-10		41A or	30	A/R	A/R		IAO LAN	R7.0
	8-1-10		41B or	75					
	8-1-10		41 or	150					
	8-1-10		42	300					
	8-1-10	ED8C727-20	167		1	1		Orderwire	
	8-1-10		178 or	150	1 or 2	1 or 2		Miscellaneous Discrete 1 — Points 1-15 1 — Inputs 16-21 (RT only)	
	8-1-10		194	50					
Power for Single OC-12 Unit and Fan Assembly	8-1-11	ED8C727-20	150		1			Shelf Power	
	8-1-11		148		1			Fan Power	
	8-1-11	ED8C724-20	371		2			Power Riser	
Cable Assembly for Fan Alarm	8-1-12	ED8C727-20	149 or		1	1			
	8-1-12	ED8C724-20	320 or	150					
	8-1-12		543	50					
Power Input Cable for Bay Arrangement of OC-12 Rear Access Units, with Fan Assembly	8-1-13	ED8C727-20	150		1	1		Shelf Power	
	8-1-13		148		1	1		Fan Power	
	8-1-13	ED8C724-22	13		1			Power Riser	

DDM-2000 OC-12 Front Access Cabling

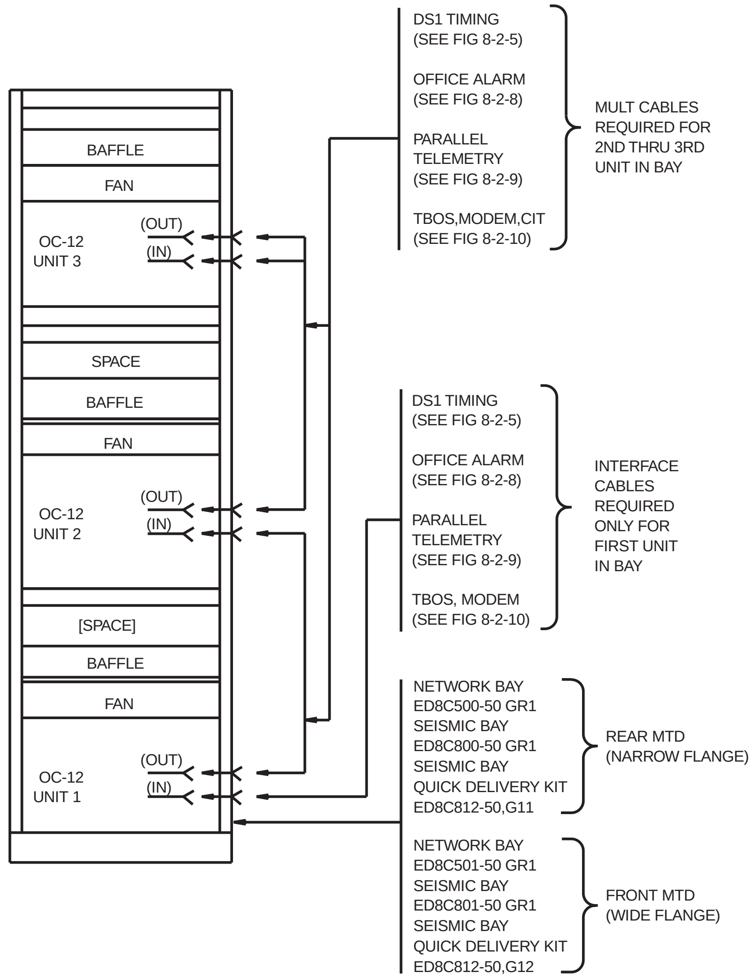

Figure 8-2-1 Typical Bay Arrangement for DDM-2000 OC-12 Front Access

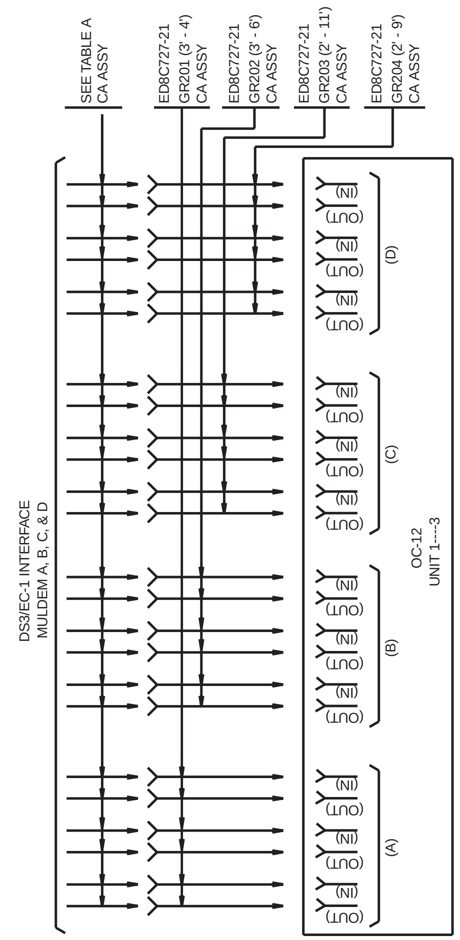

Figure 8-2-2 DS3/EC-1 Transmission Cable

TABLE A (OC-12 COAXIAL CABLE APPLICATIONS FOR FRONT ACCESS CABLING COMBINED)					
APPLICATION		CABLE TYPE****	ED8C900-12 *	MAXIMUM LENGTH	REMARKS
DSX-3,DSX 3/4, STSX-1		735A (BNC-BNC)†		250 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		250 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
DACS III-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC)†		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821AE-BNC)‡		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (9821AE-BNC)‡		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D-735A (9821AE-BNC)‡		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
DACS IV-2000	WITH BNC INTERCONNECT SHELF	735A (BNC-BNC)†		500 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		1735006A (BNC-BNC)†		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF **
		735A-734D (BNC-BNC)†		450 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
		734D (BNC-BNC)†		900 FT MAX	SIX CABLES PER MULDEM, MAX 24 CABLES PER SHELF
	WITHOUT BNC INTERCONNECT SHELF	735A (9821EA-BNC) ‡ (OUT)		500 FT MAX	THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		735A (9821FA-BNC) ‡ (IN)			THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		1735006A (9821EA/FA-BNC)‡		500 FT MAX	ONE CABLE PER MULDEM, MAX 4 CABLES PER SHELF**
		735A 734D 735A (9821EA-BNC) ‡ (OUT)		900 FT MAX	THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF
		735A 734D 735A (9821FA-BNC) ‡ (IN)			THREE CABLES PER MULDEM, MAX 12 CABLES PER SHELF

* ED-8C900-12 HAS REPLACED ED-8C900-20 FOR ALL DS3/EC-1 ORDERING.
CABLES IN THIS DRAWING ARE SORTED BY CONNECTOR TYPES.
** - EACH 1735006A CABLE CONTAINS 6 COAXIAL CABLES WITH ASSOCIATED CONNECTORS.
*** - THE G( ), DBD, 1LA CONSISTS OF A SHORT LENGTH OF 735A CABLE SPLICED TO 734D CABLE. THIS GROUP ALLOWS EASIER CONNECTION TO THE OC-12.
THE G( ), DB, 1LA MAY BE USED BUT IS NOT RECOMMENDED DUE TO THE PHYSICAL CONGESTION ON THE OC-12 BACKPLANE.
†- STRAIGHT AND RIGHT ANGEL
‡ - RIGHT ANGLE ONLY

Figure 8-2-3 DS3/EC-1 Transmission Cable

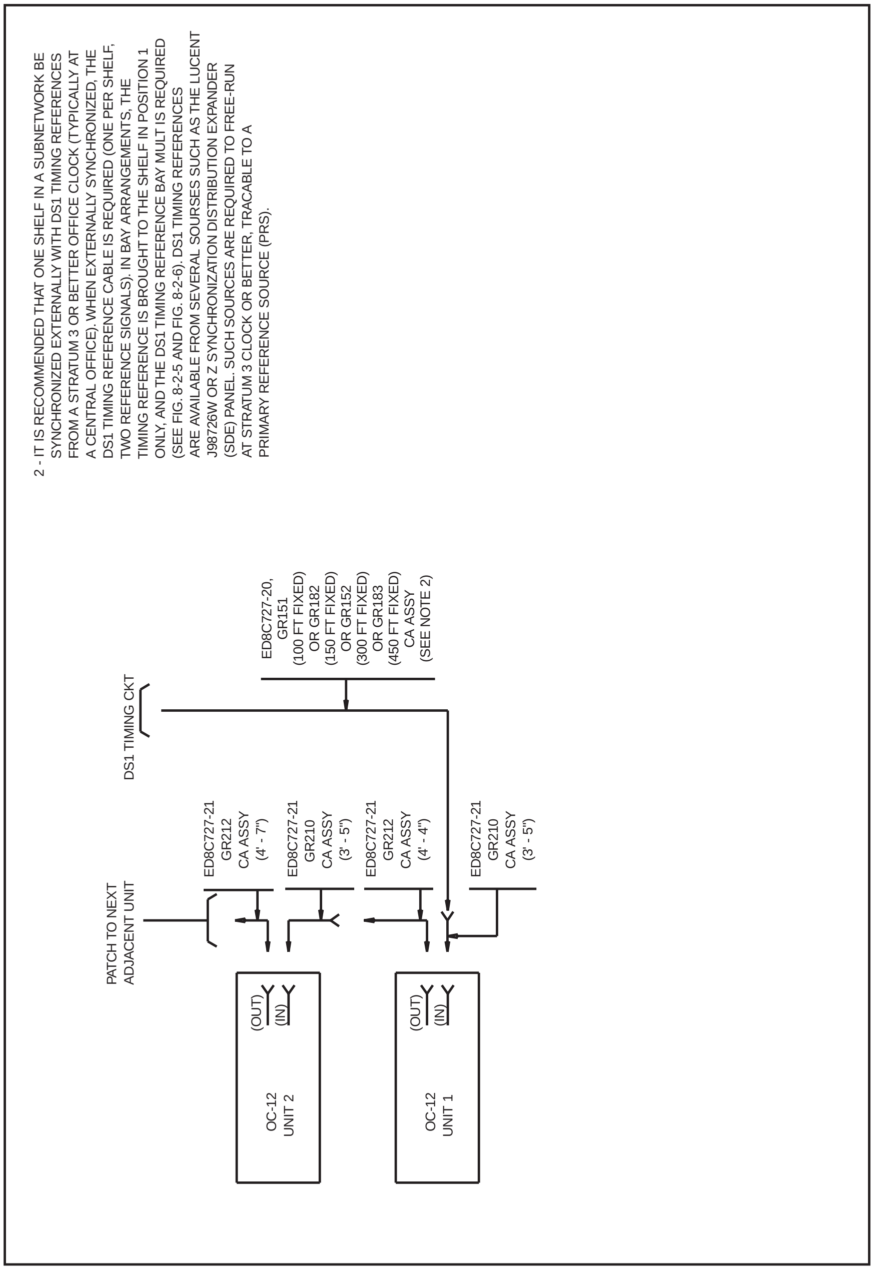

Figure 8-2-4 DS1 Timing Reference Interface and Mult Cable

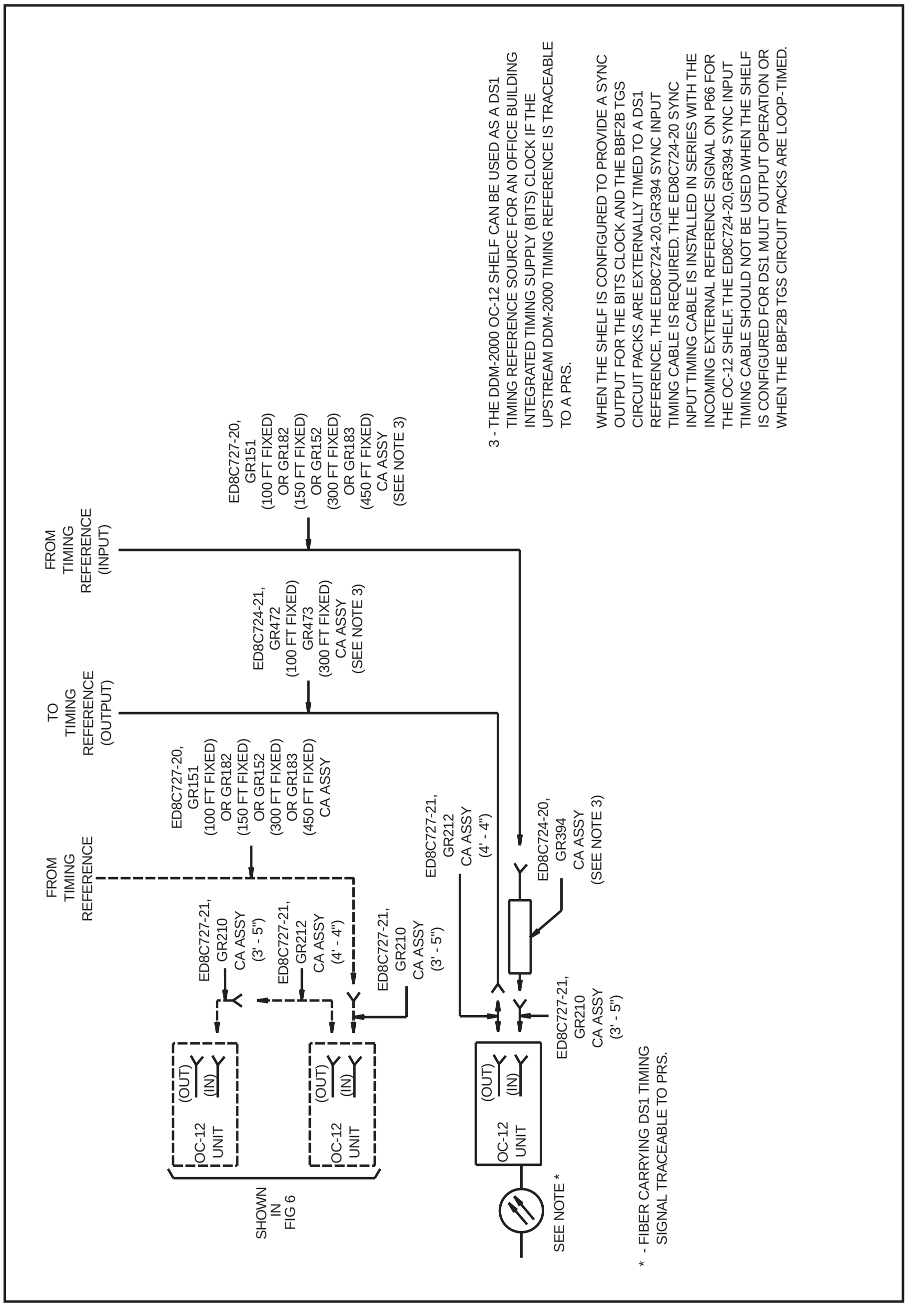

Figure 8-2-5 Synchronization for Timing Distribution Cable in a Bay Arrangement

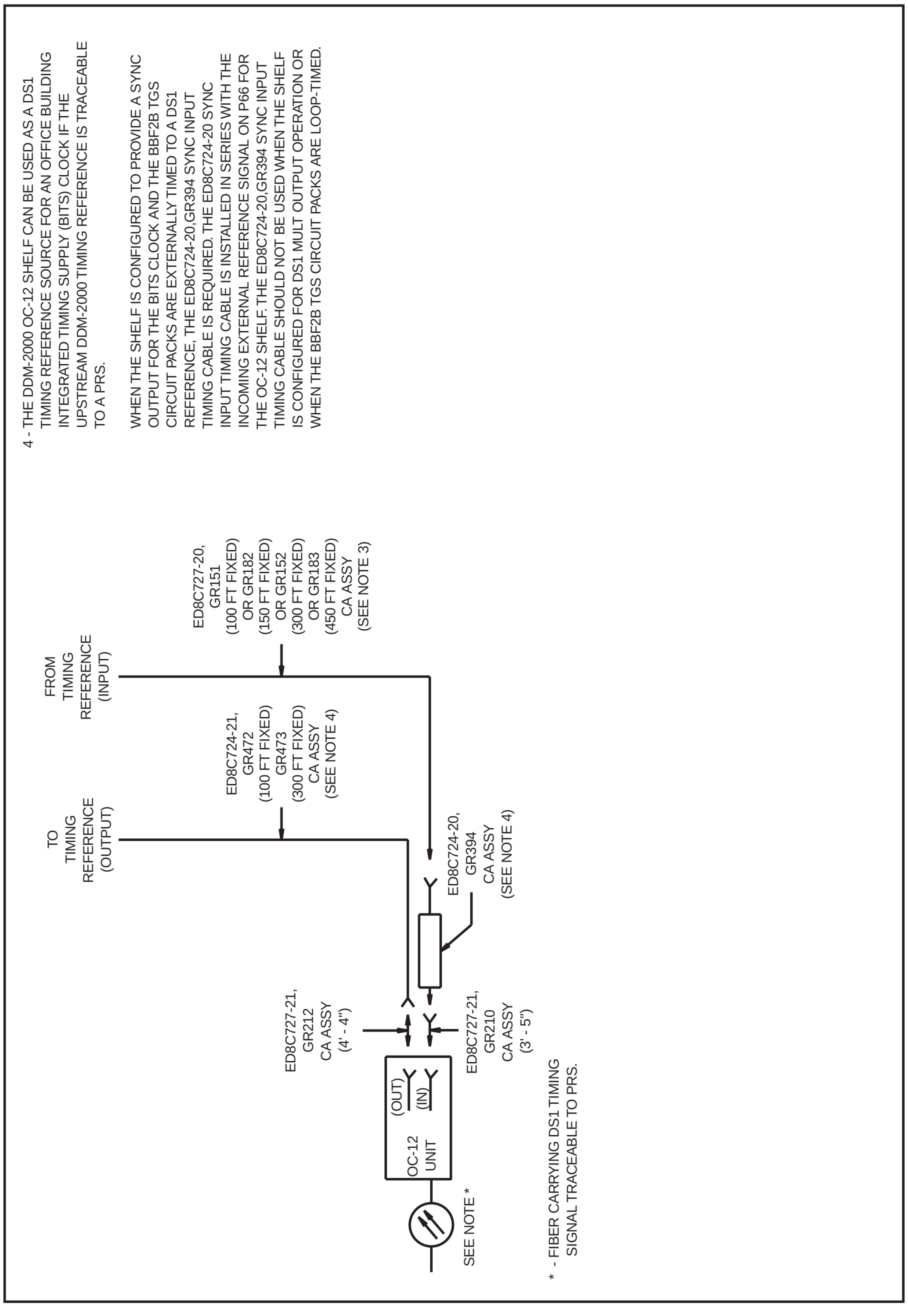

Figure 8-2-6 Synchronization for Timing Distribution Cable in a Single Shelf Assembly

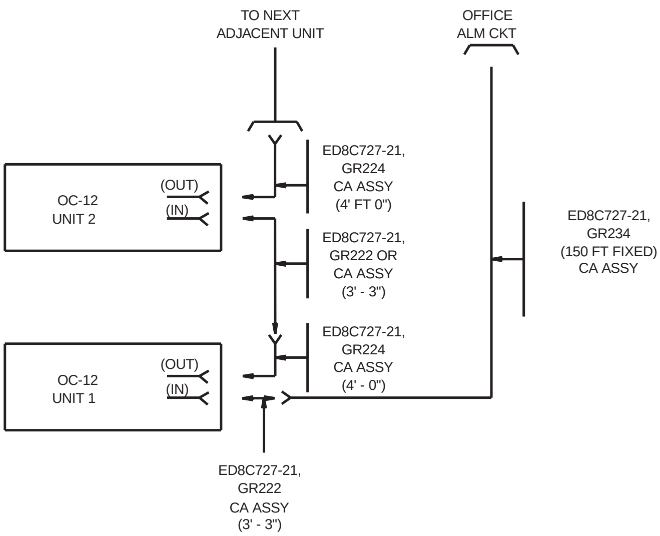

Figure 8-2-7 Office Alarm Interface and Mult Cable

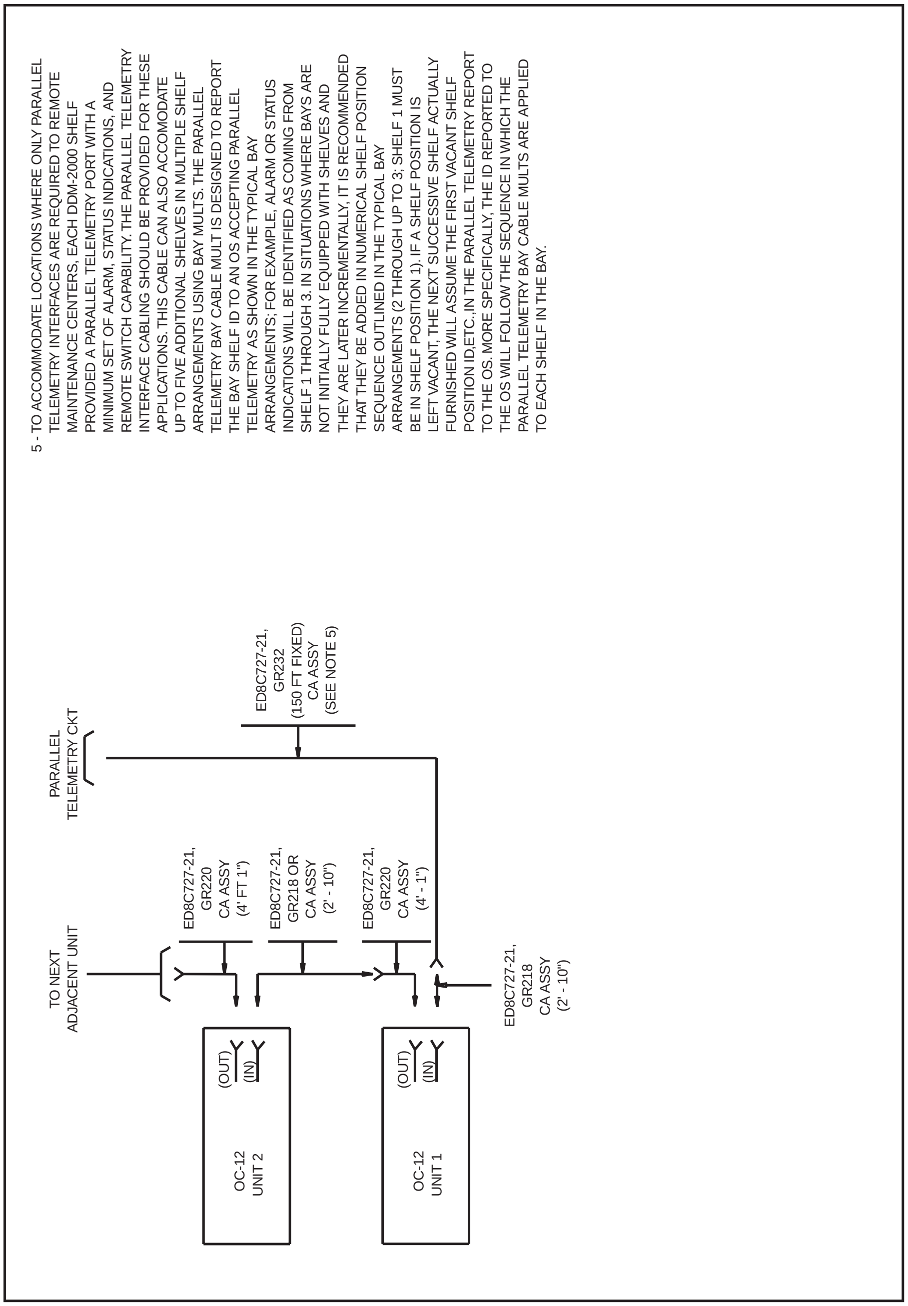

Figure 8-2-8 Parallel Telemetry Interface and Mult Cable

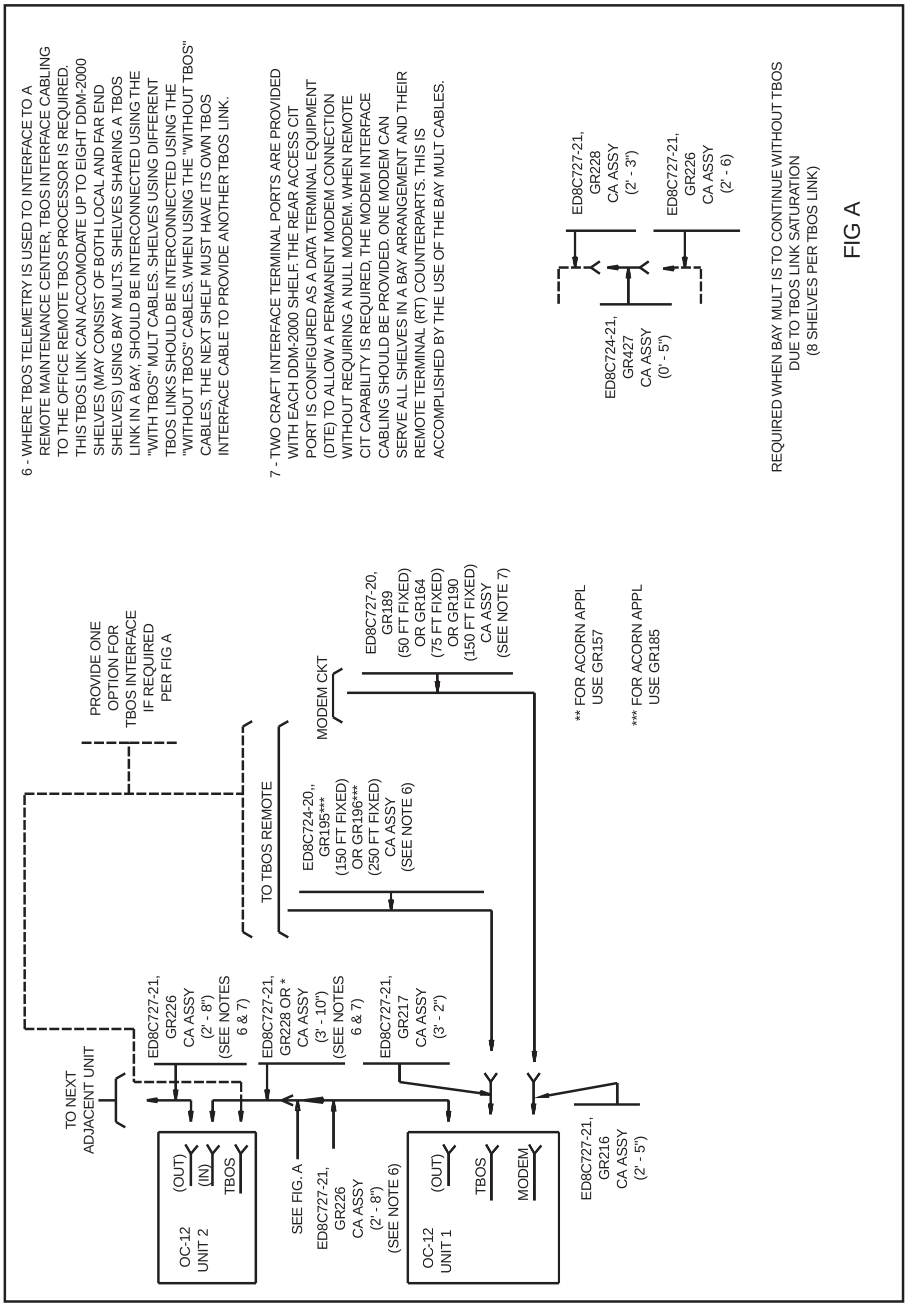

Figure 8-2-9 Modem, TBOS Interface, and Bay Mult Cable for TBOS, CIT, and Modem

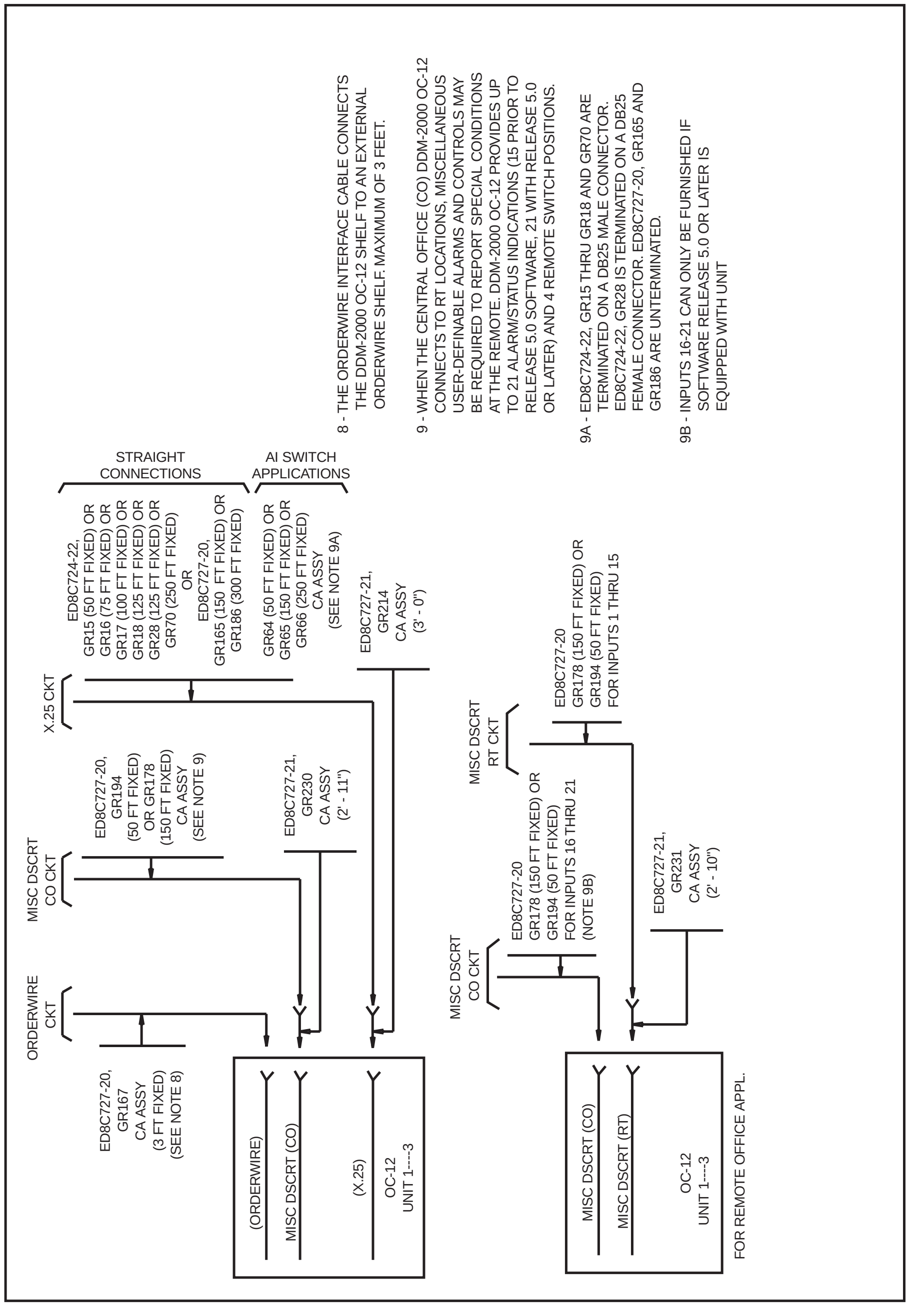

Figure 8-2-10 X.25 Interface, Miscellaneous Discretes, and Orderwire

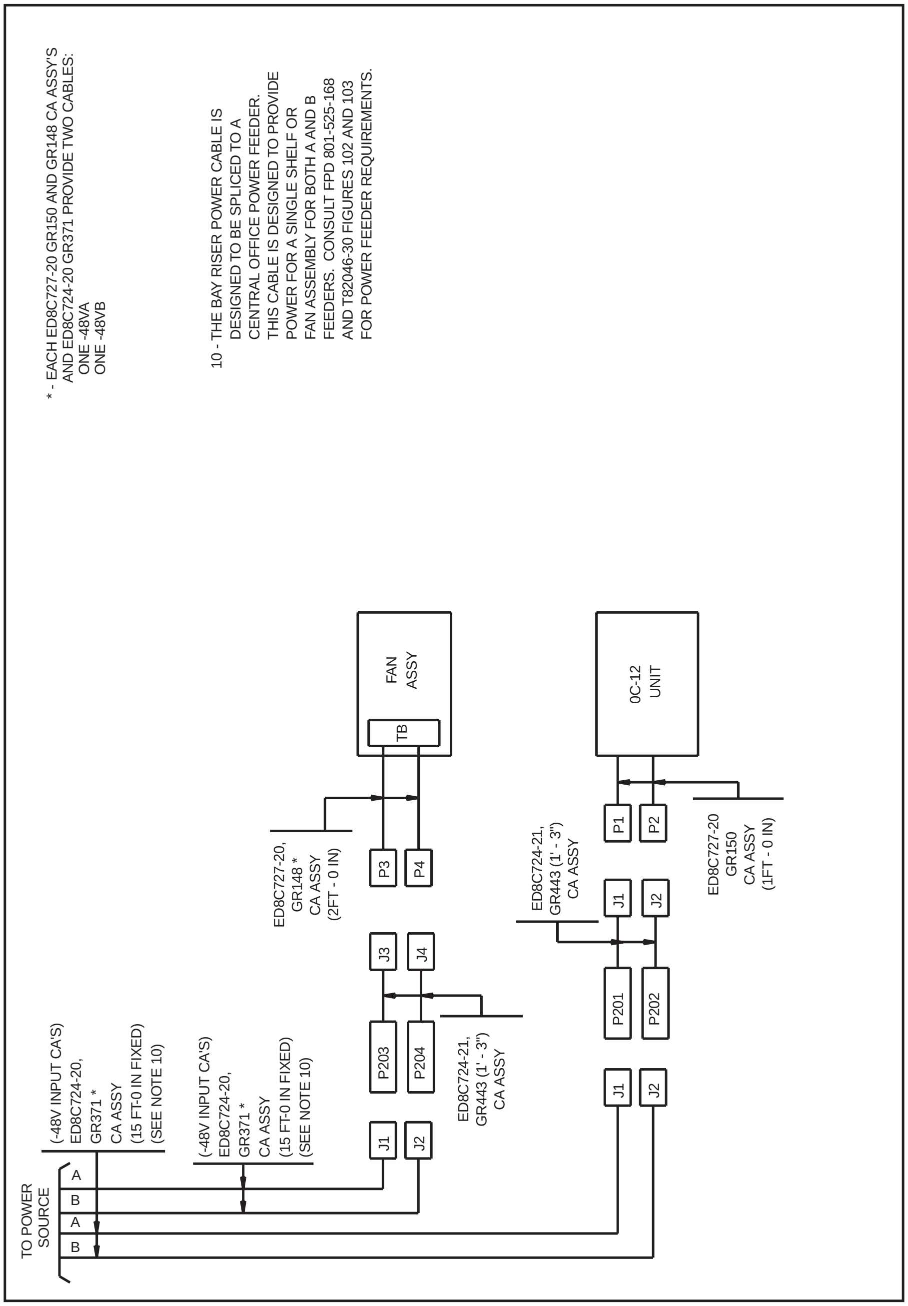

Figure 8-2-11 Power for Single OC-12 Unit and Fan Assembly

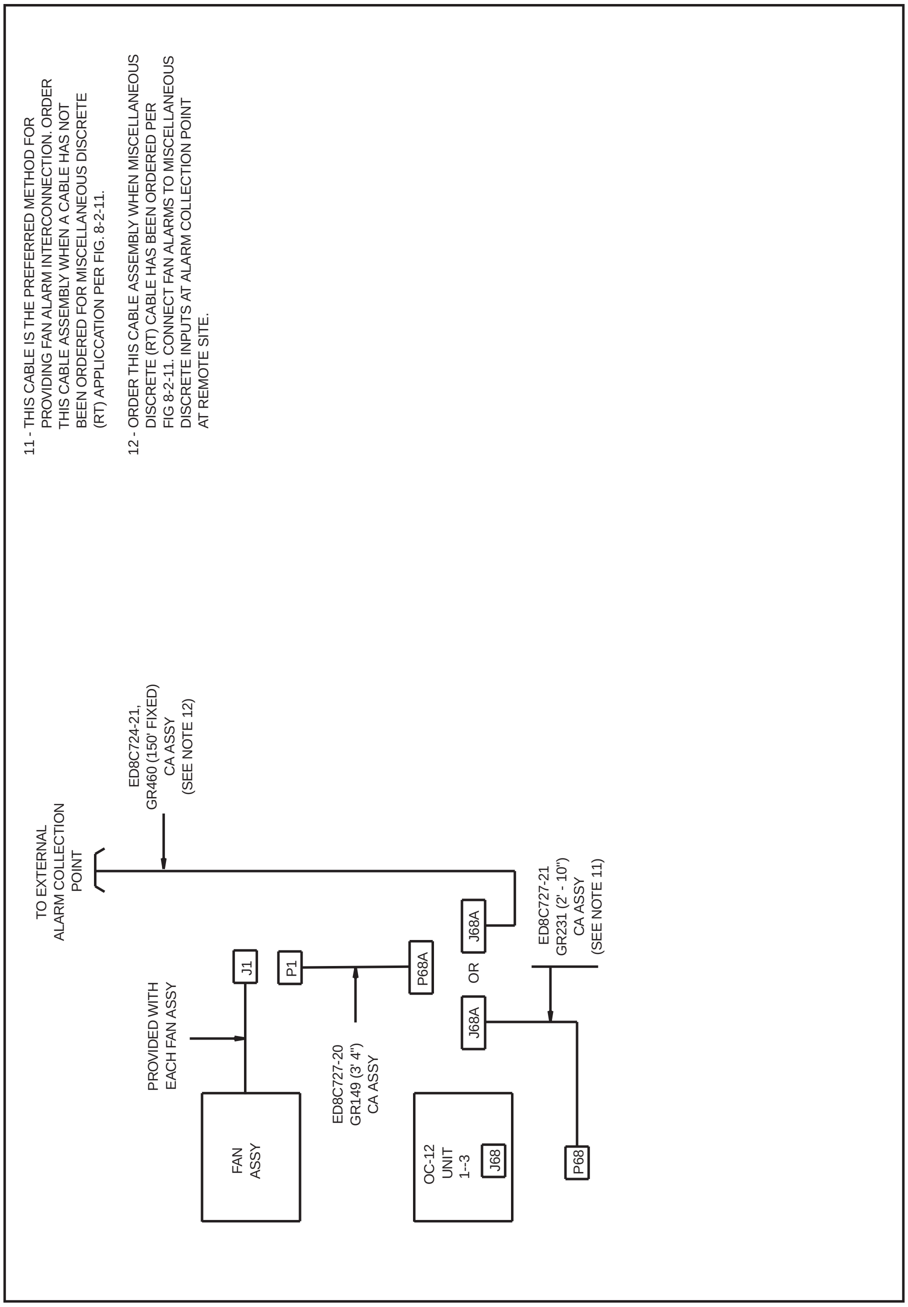

Figure 8-2-12 Cable Assembly for Fan Alarm

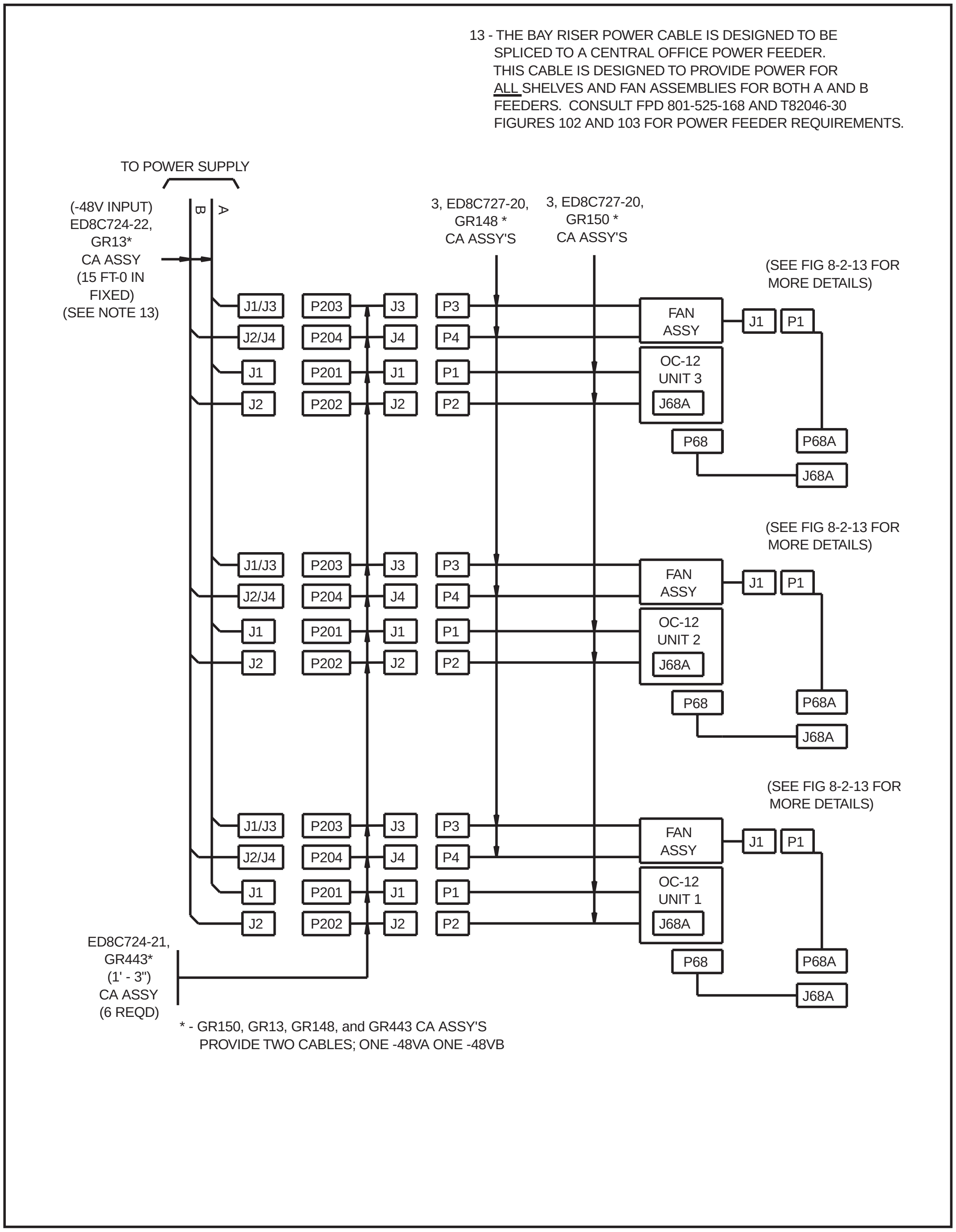

Figure 8-2-13 **Power Input Cable for Bay Arrangement of OC-12 Front Access Units With Fan Assembly**

OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 1 OF 7)

Fig. Description	Fig.	Code	Group/ Comcode Num.	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
735A Cable for DS3/EC-1 Applications When Wiring Each MULDEM on an Individual Basis	8-2-2/ 8-2-3	ED8C900-12	108799511* (Table 1U)	150	24	24		Note 1 Two Groups (cables) per MULDEM
	8-2-2/ 8-2-3	ED8C727-21	201 or		1	1		MULDEM A
	8-2-2/ 8-2-3		202 or		1	1		MULDEM B
	8-2-2/ 8-2-3		203 or		1	1		MULDEM C
	8-2-2/ 8-2-3		204		1	1		MULDEM D

* Straight BNC — loose straight BNC.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 2 OF 7)

Fig. Description	Fig.	Code	Group/ Comcode Num.	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
1735006A Cable for DS3/EC-1 Applications When All Three MULDEMS are Wired at the Same Time	8-2-2/ 8-2-3	ED8C900-12	108811548* (Table 4U)	150	4	4		Note 1 One Group per MULDEM
	8-2-2/ 8-2-3	ED8C727-21	201		1	1		MULDEM A
	8-2-2/ 8-2-3		202		1	1		MULDEM B
	8-2-2/ 8-2-3		203		1	1		MULDEM C
	8-2-2/ 8-2-3		204		1	1		MULDEM D

* Straight BNC — loose straight BNC.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 3 OF 7)

Fig. Description	Fig.	Code	Group/ Comcode Num	Enter Length (Feet) if Reqd	New Qty Reqd for First Unit in Bay	New Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
734D Cable for DS3/EC-1 Applications When Cable Length Exceeds the 735A Type Cable Requirements	8-2-2/ 8-2-3	ED8C900-12	108817800* (Table 6G)	300	24	24		Notes 1 and 2 Three Groups (cables) Required per MULDEM
	8-2-2/ 8-2-3	ED8C727-21	201			1		MULDEM A
	8-2-2/ 8-2-3		202		1	1		MULDEM B
	8-2-2/ 8-2-3		203		1	1		MULDEM C
	8-2-2/ 8-2-3		204		1	1		MULDEM D

* Straight BNC — no connector.

Note 1: For other cable lengths or connector types, please refer to ED-8C900-12.

Note 2: One end has no connector. Order with comcode 407772235 for straight BNC. See Table 7A from ED-8C900-12 for other connector types.

OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 4 OF 7)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
DS1 Timing Input and MULT Cable Required Between Adjacent Units	8-2-4	ED8C727-20	151 or	100	1			
	8-2-4		152 or	300				
	8-2-4		182 or	150				
	8-2-4		183	450				
	8-2-4	ED8C727-21	210		1	1		
	8-2-4		212		1	1		
Synchronization for Timing Distribution Cable in a Bay Arrangement	8-2-5	ED8C727-20	151 or	100	1	See Note		As Required Per Fig. 8-2-5
	8-2-5		152 or	300				
	8-2-5		182 or	150				
	8-2-5		183	450				
	8-2-5	ED8C724-20	394		1			
	8-2-5	ED8C727-21	210		1	See Note		As Required per Fig. 8-2-5
	8-2-5		212		1	See Note		As Required per Fig. 8-2-5
	8-2-5	ED8C724-21	472	100	1			
	8-2-5		473	300				
Synchronization for Timing Distribution Cable in a Single Shelf Assembly	8-2-6	ED8C727-20	151 or	100	1			
	8-2-6		152 or	300				
	8-2-6		182 or	150				
	8-2-6		183	450				
	8-2-6	ED8C724-20	394		1			
	8-2-6	ED8C727-21	212		1			
	8-2-6		210		1			
	8-2-6	ED8C724-21	472	100	1			
	8-2-6		473	300				

OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 5 OF 7)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
Office Alarm Interface and MULT Cable Required Between Adjacent Units	8-2-7	ED8C727-21	234	150	1			
	8-2-7		222		1	1		
	8-2-7		224		1	1		
Parallel Telemetry Interface and MULT Cable Required Between Adjacent Units	8-2-8	ED8C727-21	232	150	1			
	8-2-8		218		1	1		
	8-2-8		220		1	1		

OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 6 OF 7)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes	
Modem, TBOS Interface and MULT Cable for TBOS and Bay MULT Wiring Between Adjacent Units	8-2-9	ED8C727-20	164 or	75	1			Modem	
	8-2-9		189	50					
	8-2-9		190	150					
	8-2-9		157 or	150	1	A/R		TBOS	For (AT&T) ACORN Applications
	8-2-9		185 or	300					
	8-2-9	ED8C727-20	195 or	150					For Non-ACORN Applications
	8-2-9		196	250					
	8-2-9	ED8C727-21	216		1			Modem	
	8-2-9		217		1	A/R		See Fig. 8-2-10 to Determine if Needed	
	8-2-9		226		1	A/R			
	8-2-9	ED8C724-21	427			1		Only Required Per Fig. A	
	8-2-9	ED8C727-21	228			1			
X.25 Interface, Miscellaneous Discretes, and Orderwire Cables as Required for each OC-12 Unit	8-2-10	ED8C727-20	165 or	150	1	1		X.25	Unterminated
	8-2-10		186 or	300					
	8-2-10	ED8C724-22	15 or	50					Terminated on Male Connector
	8-2-10		16 or	75					
	8-2-10		17 or	100					
	8-2-10		18 or	125					
	8-2-10		70 or	250					
	8-2-10		28	125					Term. on Female Conn.
	8-2-10		64	50					AI Switch
	8-2-10		65	150					
	8-2-10		66	250					
	8-2-10	ED8C727-20	167		1	1		Orderwire	
	8-2-10		178 or	150	1 or 2	1 or 2		Miscellaneous Discrete 1 — Points 1-15 1 — Inputs 16-21 (RT only)	
	8-2-10		194	50					
	8-2-10	ED8C727-21	214		1	1		X.25	
	8-2-10		231		1	1		Miscellaneous Discrete	
	8-2-10		230		1	1			

OC-12 FRONT ACCESS CABLE ORDER BLANK (SHEET 7 OF 7)

Fig. Description	Fig.	Code	Group Num	Enter Length (Feet) if Reqd	Qty Reqd for First Unit in Bay	Qty Reqd for Each Addnl Unit in Bay	Qty to be Ordered	Notes
Power for Single OC-12 Unit and Fan Assembly	8-2-11	ED8C727-20	150		1			Shelf Power
	8-2-11		148		1			Fan Power
	8-2-11	ED8C724-20	371		2			Power Riser
	8-2-11	ED8C724-21	443		2			One Per Each Additional Unit or Fan Assembly-Power Cable
Cable Assembly for Fan Alarm	8-2-12	ED8C724-21	460 or	150	1	1		
	8-2-12	ED8C727-21	231					
	8-2-12	ED8C727-20	149		1	1		
Power Input Cable for Bay Arrangement of OC-12 Front Access Units, with Fan Assembly	8-2-13	ED8C727-20	150		1	1		Shelf Power
	8-2-13		148		1	1		Fan Power
	8-2-13	ED8C724-22	13		1			Power Riser
	8-2-13	ED8C724-21	443		2	2		One Per Each Additional Unit or Fan Assembly-Power Cable

DDM-2000 OC-12 Software Ordering

The following table contains comcode numbers for OC-12 software ordering:

Table 8-2. OC-12 Software Ordering

Equipment Code Group/List	Description
109197939	Release 5.2.4 Initial Application (floppy) and paper copy of Software Release Description
109197947	Release 5.2.4 Initial Application (CDROM) and paper copy of Software Release Description
109197954	Release 5.2.4 Upgrade Application (floppy) and paper copy of Software Release Description
109197962	Release 5.2.4 Upgrade Application (CDROM) and paper copy of Software Release Description
109197970	Release 5.2.4 Spare Software (floppy)
109197988	Release 5.2.4 Spare Software (CDROM)
109197996	Release 5.2.4 Paper Copy of Software Release Description
109192633	Release 7.0.4 Initial Application (floppy) and paper copy of Software Release Description
109192658	Release 7.0.4 Initial Application (CDROM) and paper copy of Software Release Description
109192666	Release 7.0.4 Upgrade Application (floppy) and paper copy of Software Release Description
109192674	Release 7.0.4 Upgrade Application (CDROM) and paper copy of Software Release Description
109192682	Release 7.0.4 Spare Software (floppy)
109192690	Release 7.0.4 Spare Software (CDROM)
109192724	Release 7.0.4 Paper Copy of Software Release Description
109231696	Release 7.1.2 Initial Application (floppy)
109231704	Release 7.1.2 Initial Application (CDROM)
109231712	Release 7.1.2 Upgrade Application (floppy)
109231720	Release 7.1.2 Upgrade Application (CDROM)
109231738	Release 7.1.2 Spare Software (floppy)
109231746	Release 7.1.2 Spare Software (CDROM)

Keep the following in mind before placing your order:

- DDM-2000 OC-12 software comes separately from the hardware.
- Order one set of software for each shelf.
- All system controller (SYSCTL) circuit packs are shipped without software loaded on them. Therefore, software loading must occur at or before installation. This is achieved by downloading software furnished on floppy diskettes or CDROM (both of which ship separately from the SYSCTL), using an *MS-DOS*[*] PC.
- It may be desirable to have spare diskettes for all releases on hand for backup or initial downloading.
- All network elements (NEs) in a ring or linear network, which may be part of a larger network, must be running the same software. For example, in a Release 3 OC-12 ring, you can't have some nodes running 5.0.n while others are running 5.2.n. In a maintenance subnetwork, which may consist of a mixture of ring and linear networks, all NEs must be running compatible software See Software Upgrades in Section 5, "OAM&P," for a table listing software compatibility.
- Features are included when the software is ordered by comcode.
- A user/service manual is **not** shipped with each shelf unless specified on the shelf order. Manuals can be ordered using the software ordering blank.
- The software ordering table includes a cross-reference to common language element identifier (*CLEI* [†]) codes where available.
- Information on ordering software for *CPro-2000* can be found in Table 7-5, Page 7-122.

Software orders must be placed in addition to the hardware order to receive software and to properly maintain office records.

* Registered trademark of Microsoft Corporation.

† COMMON LANGUAGE is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Bell Communications Research, Inc.

Table 8-3, Page 8-53 lists DDM-2000 OC-12 software that is no longer available.

Table 8-3. DDM-2000 OC-12 Discontinued Available (DA) Software

Product	Release	Drawing & Group(s)
OC-12	1.1/1.2	ED8C727-33, ALL
OC-12	2.X	ED8C727-34, ALL
OC-12	3.X	ED8C727-35, ALL
OC-12	5.X	ED8C727-36, ALL
OC-12	7.X	ED8C727-37, ALL
OC-12	1.0 REGEN	ED8C727-40, ALL
OC-12	2.0 REGEN	ED8C727-41, ALL

All OC-12 software is no longer orderable by ED number. Please refer to Table 8-2, Page 8-51, for codes and releases that are available. Later point releases for Releases 5 and 7 are available by comcode.

Table 8-4, Page 8-54 lists what applications are supported by which release. Since the OC-12 Regenerator does not access the data communications channel, OC-12 Regenerator software is compatible with all OC-12 software releases and can be used in all OC-12 applications.

Table 8-4. DDM-2000 OC-12 Multiplexer Application Summary Matrix

Application	Linear	Ring			
	R2.3	**R3.1**	**R5.0/5.1**	**R5.2**	**R7.0**
OC-12 Point-to-Point	**X**				
OC-12 Hub	X				
OC-12 STS-1 Ring		X	X	X	X
EC-1 DRI w/STS-1Drop and continue		X	X	X	X
OC-3c Transport	X		X	X	X
OC-12 w/EC-1 low-speed	X	X	X	X	X
Linear Ext. from OC-3 Ring	X				
OC-3/OC-12 Ring with 0x1		X	X	X	X
OC-3 linear Ext. from OC-12 ring			X	X	X
OC-3 DRI w/STS-1Drop and continue			X	X	X
Dual homing of OC-3 Ring			X	X	X
STS-3c broadcast			X	X	X
STS-3c 0x1				X	X
Multivendor Operations Interworking					X

Table 8-5. Software Compatibility for DDM-2000 OC-12

OC-12 Software Releases	OC-1 Software					OC-3 Software											OC-12 Software						OC-48 Software					
	2.1	2.2	3.0	3.1**	4.0**	6.2	7.1	7.2	8.0	8.1	9.0	9.1	11.0	11.1	13.0	15.0	2.3	3.1	5.0	5.1	5.2	7.0	6.0	7.0	7.1	7.2	9.0	9.1
OC-12, R2.3	NC	NC	NC	NC	NC	C	C	NC	NC	NC	NC	NC	NC	NC	NC	NC	C	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
OC-12, R3.1	NC	NC	NC	NC	NC	NC	C	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	C	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
OC-12, R5.0	C*	NT	NC	NC	NC	NC	NC	C	C	C	C	C	NT	NT	NC	NC	NC	NC	C	NT	NT	NC	C	C	NT	NT	NC	NC
OC-12, R5.1	C*	C	NC	NC	NC	NC	NC	C	C	C	NT	C	C	C	NC	NC	NC	NC	NT	C	NT	NC	NT	C	C	C	NC	NC
OC-12, R5.2	C*	C	NC	NC	NC	NC	NC	C	C	C	NT	C	C	C	NC	NC	NC	NC	NT	NT	C	NC	NT	C	C	C	NC	NC
OC-12, R7.0	NC	NC	C*	C	C	NC	NC	NC	NC	NC	NC	NC	NC	NC	C	C	NC	NC	NC	NC	NC	C	NC	NC	NC	NC	C	C

C - DCC Compatible Releases
C* - Compatible if included in the same subnetwork but shelves can not be physically interconnected
NT - Not Tested
NC - Not Compatible
** - Assumes FiberReach has OC-3 optics

OC-12 Plug-Ins

Individual Plug-In Ordering

This section provides an order blank for individual plug-in orders. It also includes sparing recommendations based on reliability projections for each plug-in unit. Before describing the plug-in ordering, a brief description of the shelf layout and optional plug-ins is in order. Refer to Figure 8-23, Page 8-57 for DDM-2000 OC-12 Multiplexer terminal and ring applications.

Ring Applications

Release 3 supports one System controller-SYSCTL (BBG5), one overhead controller-OHCTL (BCP1), one synchronous timing generator-TGS (BBF2B, BBF2C, or BBF4), two time slot interchange-TSI (BCP3), and two OC-12 optical line interface unit-OLIU (23G-U/23H-U) are always required. Protection circuit packs are optional for the TGS plug-ins.

The Function Unit slots are equipped depending on the application. The OC-12 ring supports both DS3 and EC-1 low speed interfaces, as well as OC-3 (21D-U, 21G3-U) interfaces to a local or remote OC-3 shelf equipped with Release 7 or later software. As such, the 3DS3 (BBG11B) and 3STS1E (BBG12) circuit packs can be equipped as described in the "Terminal Applications" section. The OC-3 interfaces are configured in a 0x1 configuration to connect to the OC-3 shelf. See Section 7, "Plug-Ins," for an example of this application. Also, as described in the "Terminal Applications" section, apparatus blanks must be used in Main and Function Unit slots that are not equipped.

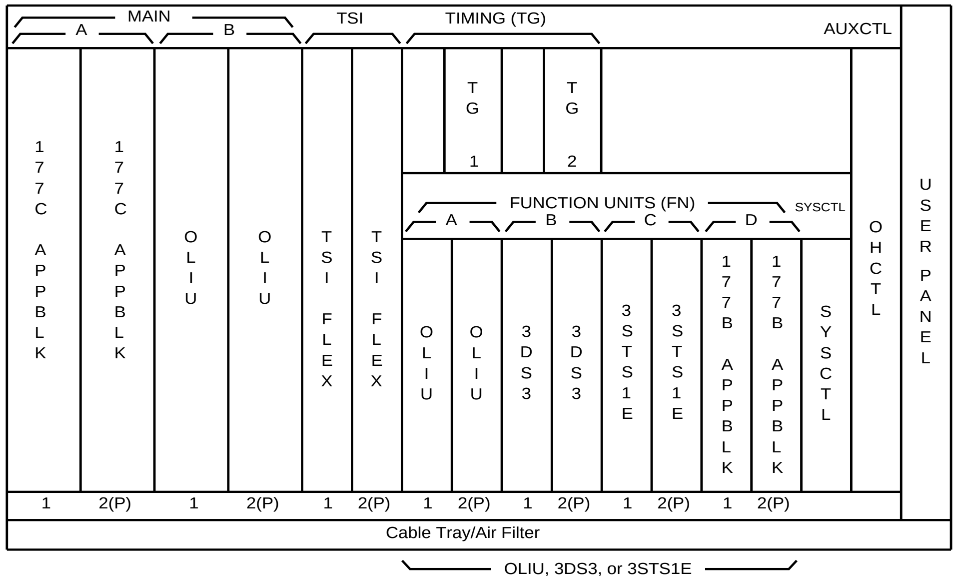

Figure 8-23. DDM-2000 OC-12 Multiplexer Ring Shelf Layout

Release 5.0 is for ring applications and includes three plug-ins: the BBG8B SYSCTL (used in OC-3), the BCP4 OHCTL, and the BBG11B 3DS3 circuit packs. The new controller circuit packs are required for Release 5.0 and higher releases. The BBG11B 3DS3 circuit pack is replacing the BBG11 3DS3 circuit pack but is only required if enhanced DS3 performance monitoring is needed. Release 5.0 supports operations interworking with other Lucent Technologies 2000 Product Family products, enhances the "drop and continue" feature to OC-3/IS-3 interfaces for dual ring interworking (DRI) applications, and dual homing, linear 1+1 optical extensions, OC-3c transport, and STS-3c broadcast applications. Release 5.0 also supports larger networks and several OAM&P enhancements.

Typical Equipage Applications

The following figures and associated tables show some typical shelf applications for the DDM-2000 OC-12 Multiplexer.

- OC-12 Hub Shelf equipped with (E/W) 3 DS3 Circuits and 2 OC-3 Optical Extensions (Figure 8-24, Page 8-59)
- OC-12 End Terminal Shelf E/W 12 EC-1 Circuits (Figure 8-25, Page 8-60)
- OC-12 Ring Shelf E/W 6 DS3 Circuits and 6 EC-1 Circuits (Figure 8-26, Page 8-61)
- OC-12 Regenerator Shelf Equipped to Regenerate 4 Optical Lines (Figure 8-27, Page 8-62).

NOTE:
In the tables associated with each figure, the slash (/) separates the old shelf, old controllers, and earlier software from the new shelf, new controllers, and new software.

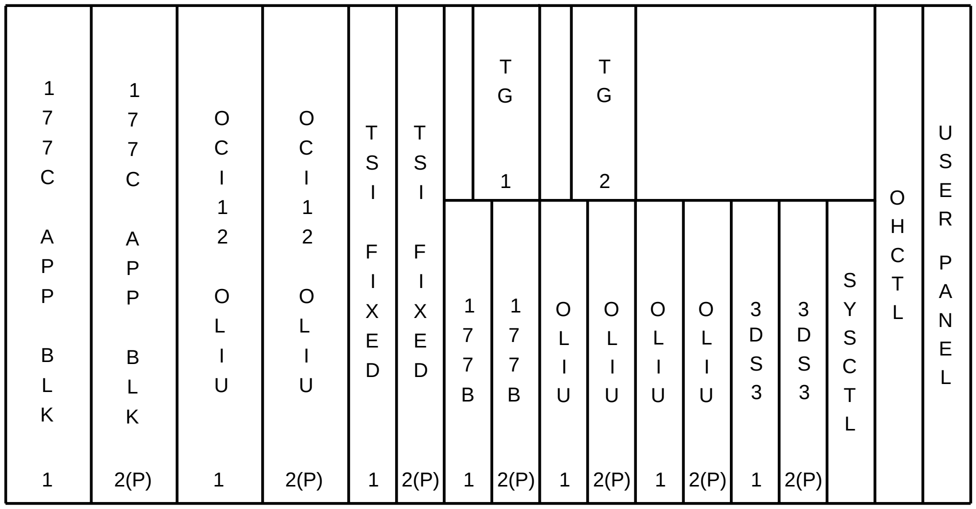

Figure 8-24. OC-12 Hub Shelf E/W 3 DS3 Circuits and 2 OC-3 Optical Extensions

Quantity	Description	Apparatus/ED Code
1	OC-12 Shelf Assembly w/Manual	ED-8C727-30 G4, A
2	TGS Timing Generator	BBF2B/BBF2C
4	OC-3 Optical Line Interface Unit	21-type
1	SYSCTL System Controller	BBG5
1	OC-12 OHCTL Overhead Controller	BCP1
2	TSI FIXED	BCP2
2	OC-12 Optical Line Interface Unit	23G-U or 23H-U
2	8 inch App. Blk.	177B
2	12 inch App. Blk.	177C
2	Triple DS3 CPs	BBG11B
1	OC-12 R2.3 software *	

* Software must be ordered separately. See "Software Ordering" section.

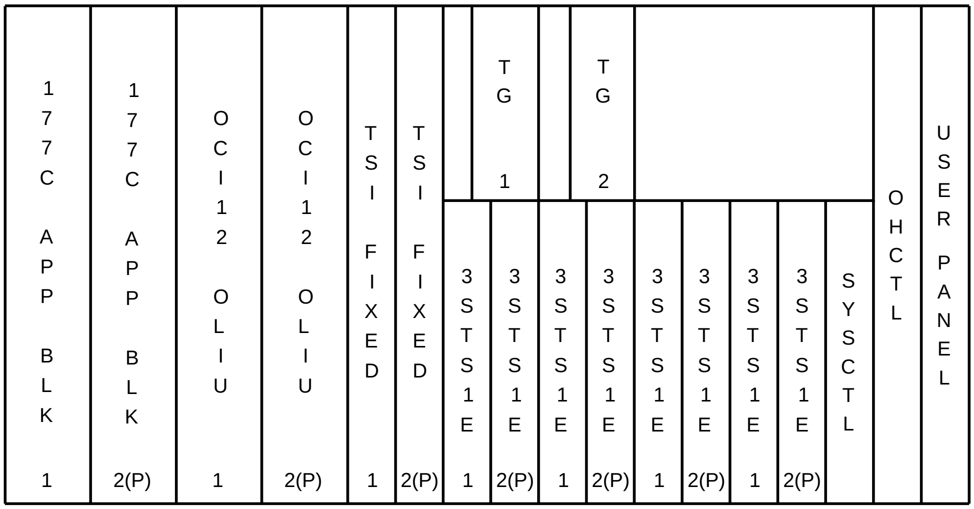

Figure 8-25. OC-12 End Terminal Shelf E/W 12 EC-1 Circuits

Quantity	Description	Apparatus/ED Code
1	OC-12 Shelf Assembly w/Manual	ED-8C727-30 G4, A
2	TGS Timing Generator	BBF2B/BBF2C
1	SYSCTL System Controller	BBG5
1	OC-12 OHCTL Overhead Controller	BCP1
2	TSI FIXED	BCP2
2	OC-12 Optical Line Interface Unit	23G-U or 23H-U
2	12 inch App. Blk.	177C
8	Triple STS1E CPs	BBG12
1	OC-12 R2.3 software *	

* Software must be ordered separately. See "Software Ordering" section.

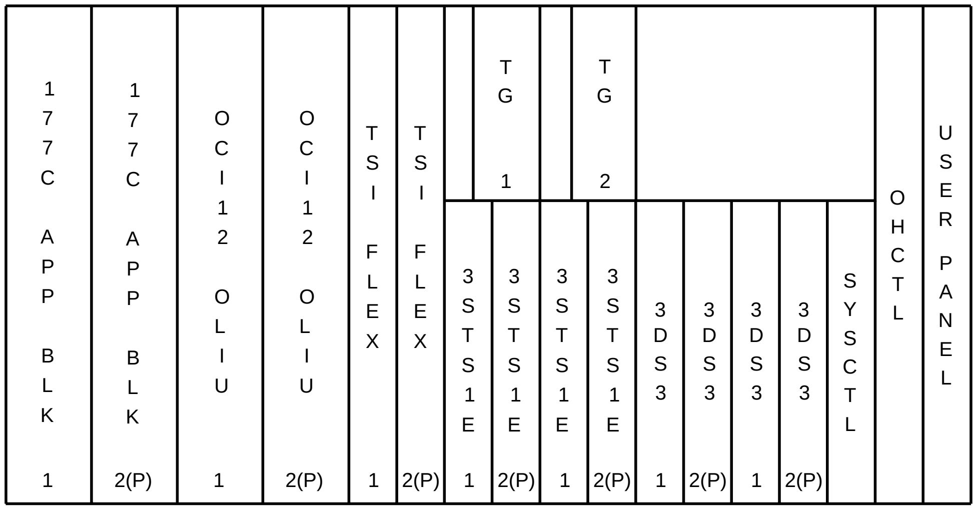

Figure 8-26. OC-12 Ring Shelf E/W 6 DS3 Circuits and 6 EC-1 Circuits

Quantity	Description	Apparatus/ED Code
1	OC-12 Shelf Assembly w/Manual	ED-8C727-30 G4, A/D/E ‡
2	TGS/TG3 Timing Generator	BBF2B/BBF2C/BBF4
1	SYSCTL System Controller	BBG5/BBG8B
1	OC-12 OHCTL Overhead Controller	BCP1/BCP4
2	TSI FLEX	BCP3 †
2	OC-12 Optical Line Interface Unit	23G-U or 23H-U
2	12 inch App. Blk.	177C
4	Triple DS3 CPs	BBG11B
4	Triple STS1E CPs	BBG12
1	OC-12 R3/R5/R7 software *	

* Software must be ordered separately. See "Software Ordering" section.

† For ring applications, 2 BCP3 circuit packs must be equipped regardless of whether or not protection is desired.

‡ Group A for R3, Group D for R5.x, Group E for R7.

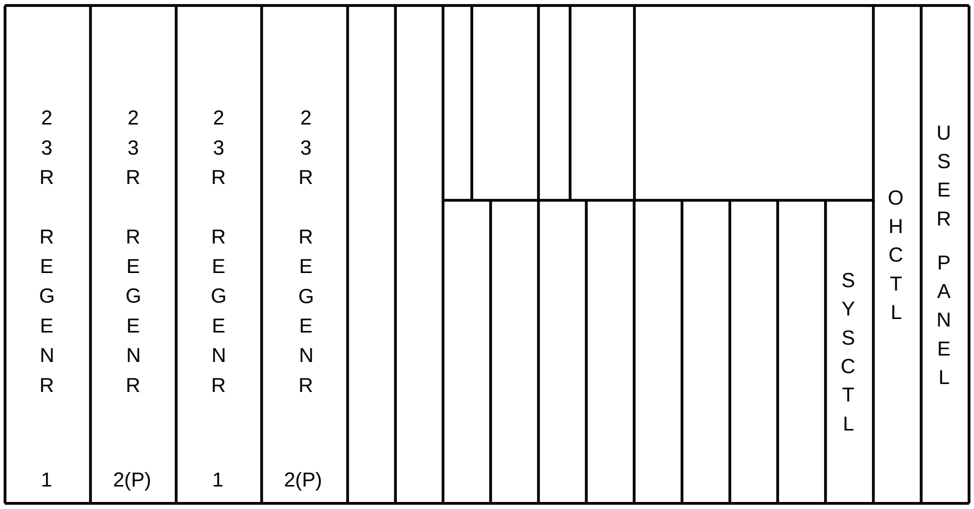

Figure 8-27. OC-12 Regenerator Shelf Equipped to Regenerate 4 Optical Lines

Quantity	Description	Apparatus/ED Code
1	OC-12 Shelf Assembly w/Manual	ED-8C727-30 G1 or G4, A
1	SYSCTL System Controller	BBG5
1	OC-12 OHCTL Overhead Controller	BCP1
4	OC-12 Regenerator CPs	23R-U
1	OC-12 Regenerator R2 software *	

* Software must be ordered separately. See "Software Ordering" section.

Table 8-6, Page 8-63 and Table 8-7, Page 8-65 are tables of circuit pack types that are allowed by release for the DDM-2000 OC-12 Multiplexer and the OC-12 Regenerator respectively.

Use the tables in the following way: Pick one circuit pack from each column to build an application. For example in Release 2.0, there is only one choice for Main-A, TSI, AUXCTL, and SYSCTL slots. However, any combination of BBG11/11B, BBG12, 21D/21D-U, or 21G/21G-U OLIUs are allowed in the Function Unit. Provisioning rules require that both slots of a 1X1 pair have the same circuit pack type. For releases that support two TGS circuit pack types, or that support multiple OLIU circuit pack types, these units can be mixed if they follow the provisioning rules.

Table 8-6. DDM-2000 OC-12 Multiplexer Circuit Pack and Software Compatibility Matrix

Release Number	Slot Name						
	Main-A	Main-B	TSI	TG	FN	SYSCTL	AUXCTL
1.0§ (Linear)	**177C**	**23G/23G-U 23H/23H-U**	**BCP2**	**BBF2§ BBF2B* BBF2C**	**BBG11/11B 177B**	**BBG5**	**BCP1**
1.1§ (Linear)	177C	23G/23G-U 23H/23H-U	BCP2	**BBF2§ BBF2B* BBF2C**	21G/21G-U§ BBG11/11B 177B	BBG5	BCP1
1.2§ (Linear)	177C	23G/23G-U 23H/23H-U	BCP2	**BBF2§ BBF2B* BBF2C**	21G/21G-U§ 21D/21D-U§ BBG11/11B 177B	BBG5	BCP1
2.0§ (Linear)	177C	23G/23G-U 23H/23H-U	BCP2	**BBF2§ BBF2B* BBF2C**	21G/21G-U§ 21D/21D-U§ BBG11/11B 177B	BBG5	BCP1
2.1§, 2.2§, and 2.3 (Linear)	177C	23G/23G-U 23H/23H-U	BCP2	**BBF2§ BBF2B* BBF2C**	21G/21G-U§ 21D/21D-U§ BBG11/11B 177B BBG12	BBG5	BCP1
3.0§ (Ring)	177C	23G/23G-U 23H/23H-U	BCP3	**BBF2§ BBF2B* BBF2C**	BBG11/11B BBG12 177B	BBG5	BCP1

Table 8-6. DDM-2000 OC-12 Multiplexer Circuit Pack and Software Compatibility Matrix (Contd)

Release Number	Slot Name						
	Main-A	Main-B	TSI	TG	FN	SYSCTL	AUXCTL
3.1 (Ring)	177C	23G/23G-U 23H/23H-U	BCP3	**BBF2§ BBF2B* BBF2C**	21G/21G-U§ 21D/21D-U§ BBG11/11B 177B BBG12	BBG5	BCP1
5.0§, 5.1§ 5.2 (Ring)	**177C**	**23G/23G-U 23H/23H-U**	**BCP3**	**BBF2B* BBF2C**	**21G/21G-U§ 21D/21D-U§ BBG11/11B† BBG12 177B**	**BBG8 BBG8B**	**BCP4**
7.0, (Ring)	**177C**	**23G/23G-U 23H/23H-U**	**BCP3**	**BBF2B* BBF2C BBF4**	**21G/21G-U§ 21D/21D-U§ BBG11/11B† BBG12 177B**	**BBG8 BBG8B**	**BCP4**

* The BBF2B circuit pack optionally provides DS1 timing outputs. In Release 1.0, the BBF2B can be used if it is provisioned to have the same functionality as the BBF2. Release 1.2 and later releases, recognize both the BBF2 and BBF2B and provide DS1 timing outputs if the BBF2B is provisioned. The BBF2B TGS is recommended for rings to minimize protection switching times in case of a manual circuit pack removal. The BBF2 circuit pack has been rated discontinued availability (DA).

† BBG11B required in Release 5.0 to support enhanced DS3 performance monitoring. Will replace the BBG11.

‡ Series 2:5 or later.

§ Software Releases R1.0, R1.1, R2.0, R2.1, R2.2, R3.0, R5.0, R5.1 and the BBF2, 21G, and 21D circuit packs have been rated discontinued availability (DA).

Table 8-7. DDM-2000 OC-12 Regenerator Circuit Pack and Software Compatibility Matrix

Release Number	Slot Name						
	Main-A	Main-B	TSI	TG	FN	SYSCTL	AUXCTL
2	23R2	23R2	empty	empty	empty	BBG5 *	BCP1

* Must be Series 2:2 or later.

Plug-In Maintenance Sparing Guidelines

Table 8-8, Page 8-66 provides a guideline for determining the number of DDM-2000 OC-12 Multiplexer plug-in spares needed for a given number of plug-ins in the field. The sparing guide serves as an initial estimate and is calculated with the following assumptions:

- The method for calculating spares follows the procedure described in Telcordia Technologies SR-TSY-000385, Issue 1.
- The steady-state failure rate is assumed. Failure rates are based on the reliability prediction procedure (RPP) method described in TR-TSY-000332, Issue 3.
- The spare availability objective (SAO) is 99 percent. The SAO is the long-term probability that a spare plug-in is available when it is needed.
- A no-trouble-found (NTF) factor of 1.67 is multiplied to the failure rate. This accounts for replacements of plug-ins when actually no failure has occurred. The NTF factor is expected to approach 1.25 as the product matures. The likelihood of an NTF decreases as the product matures, and sparing needs will therefore diminish over time.
- Turnaround time of a returned plug-in is 4 weeks.

Table 8-8, Page 8-66 shows how many plug-ins in the field can be supported by a given number of spares (NS).

Table 8-8. Sparing Guidelines

Plug-In Code	Number of Spares					
	NS=1	NS=2	NS=3	NS=4	NS=5	NS=6
BBF2 (TGS)	**91**	**280**	**534**	**826**	**1158**	**1497**
BBF2B (TGS)	**108**	**332**	**632**	**979**	**1373**	**1774**
BBF2C (TGS)	**106**	**327**	**623**	**965**	**1353**	**1748**
BBF4 (TG3)	**106**	**327**	**623**	**965**	**1353**	**1748**
BBG5 (SYSCTL)	47	145	277	428	600	776
BBG8 (SYSCTL)	55	170	324	502	704	910
BBG8B (SYSCTL)	56	173	329	510	714	923
BBG11 (3DS3)	79	244	465	720	1009	1304
BBG11B (3DS3)	79	244	465	720	1009	1304
BBG12 (3STS1E)	96	296	565	875	1227	1585
BCP1 (OHCTL)	49	152	289	448	628	812
BCP2 (TSI)	85	262	500	775	1088	1403
BCP3 (TSI)	93	285	543	841	1178	1523
BCP4 (OHCTL)	25	77	146	226	317	410
21D (OLIU)	127	391	746	1155	1619	2092
21D-U (OLIU)	184	566	1078	1670	2341	3025
21G (OLIU)	39	121	230	357	500	646
21G-U (OLIU)	97	297	567	878	1230	1590
21G2-U (OLIU)	61	188	358	554	776	1003
21G3-U (OLIU)	141	433	827	1280	1794	2318
23G (OLIU)	25	76	146	226	316	409
23G-U (OLIU)	28	85	162	251	352	454
23H (OLIU)	19	60	114	176	247	319
23H-U (OLIU)	22	66	127	196	275	355
23R (REGENR)	30	92	175	271	379	490
23R-U (REGENR)	25	78	149	231	323	418
Fan Shelf	25	78	148	229	321	415
Fan Pack	125	383	731	1132	1586	2049

Example:

- Plug-in code = BBF2B.
- If you have between 100 and 240 BBF2B plug-ins in service, the number of BBF2B spares recommended is 2 (NS=2).

Table 8-9, Page 8-67 is a worksheet for the OC-12 shelf showing the number of plug-ins required. After calculating the number required, transfer these numbers to the OC-12 Plug-In Order Blank, Table 8-11, Page 8-71.

Table 8-9. OC-12 Plug-In Worksheet (Per Shelf)

Slot Name	Product Codes	Min./Shelf *	Max./Shelf *	Qty. Ordered
TG	BBF2B/BBF2C/BBF4	2	2	
Main A OLIU	177C	2	2	
Main B OLIU	23G-U or 23H-U	2	2	
TSI	BCP2 or BCP3 ¶	2	2	
Function Unit	BBG11B or BBG12 or 21D-U or 21G2-U/21G3-U or 177B	8§	8	
AUXCTL †	BCP4	1	1	
SYSCTL †	BBG8B	1	1	

* Minimum and maximum quantities per shelf, as defined here, includes protection switching capability, thus protection plug-ins are included.

† Use BCP4 and BBG8B as a pair.

§ Any Function Unit slot not filled with an active circuit pack (BBGxx or 21x) must be filled with a 177B Apparatus Blank such that all slots are filled.

¶ For ring applications, 2 BCP3 circuit packs must be equipped regardless of whether or not protection is desired.

Universal Connector OLIUs

All DDM-2000 OC-12 OLIUs have a new universal optical connector version designated by a -U. Figure 8-28 shows the connector. This connector is a two-part connector consisting of a faceplate-mounted block and an optical buildout. The faceplate block optionally supports an *ST*®, SC, or FC-PC type optical buildout.

A 0 dB SC-type connector is shipped as standard with each OLIU. Table 8-10 lists single-mode (SM) and multimode (MM) attenuated buildouts.

A 15 dB *ST* lightguide buildout assembly is needed for loopback testing of the 23G OLIU and a 4C test cable for loopback testing of the 23H OLIU. See the "OC-12 — Miscellaneous Equipment and Tools" section for ordering information.

Table 8-10. Universal Buildout Attenuators

Description	Connection	Loss (dB)	Comcode
A3060 SC 0 dB buildout	SM-SM & MM-MM	0	106708951
A3060B1 SC 5 dB buildout	SM-SM	5	107406142
A3060D1 SC 10 dB buildout	SM-SM	10	107406159
A3060F1 SC 15 dB buildout	SM-SM	15	107406167
ASCM5 SC 5 dB buildout	SM-MM	5	108440579
ASCM10 SC 10 dB buildout	SM-MM	10	108440595
ASCM15 SC 15 dB buildout	SM-MM	15	108440611
ASCM20 SC 20 dB buildout	SM-MM	20	108440637
A3070 *ST*® 0 dB buildout	SM-SM & MM-MM	0	106795354
A3070B1 *ST*® 5 dB buildout	SM-SM	5	107406183
A3070D1 *ST*® 10 dB buildout	SM-SM	10	107406191
A3070F1 *ST*® 15 dB buildout	SM-SM	15	107406209
ASTM5 SC 5 dB buildout	SM-MM	5	108052960
ASTM10 SC 10 dB buildout	SM-MM	10	108052994
ASTM15 SC 15 dB buildout	SM-MM	15	108053018
ASTM20 SC 20 dB buildout	SM-MM	20	108053042
A3080 FC 0 dB buildout	SM-SM & MM-MM	0	106795404
A3080B1 FC 5 dB buildout	SM-SM	5	107406225
A3080D1 FC 10 dB buildout	SM-SM	10	107406233
A3080F1 FC 15 dB buildout	SM-SM	15	107406241
AFCM5 FC 5 dB buildout	SM-MM	5	108107285
AFCM10 FC 10 dB buildout	SM-MM	10	108107301
AFCM15 FC 15 dB buildout	SM-MM	15	108107327
AFCM20 FC 20 dB buildout	SM-MM	20	108107343
A2060B SC 5 dB buildout	MM-MM	5	106795271
A2060D SC 10 dB buildout	MM-MM	10	106795289
A2060F SC 15 dB buildout	MM-MM	15	106795297
A2070B *ST*® 5 dB buildout	MM-MM	5	106795313
A2070D *ST*® 10 dB buildout	MM-MM	10	106795321
A2070F *ST*® 15 dB buildout	MM-MM	15	106795339

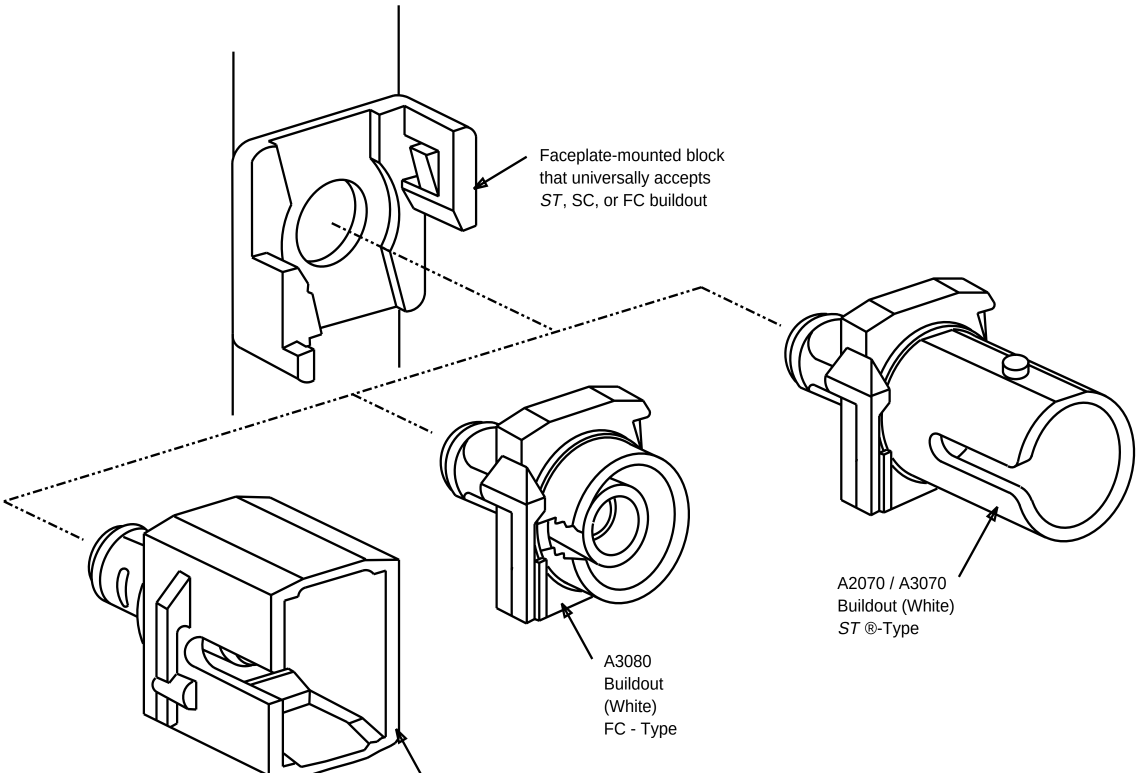

Figure 8-28. Universal Optical Connector

Table 8-11. DDM-2000 OC-12 Plug-In Order Blank

Quantity Ordered	Product Code	COMCODE	CLEI * Code	Functional Name	Functional Designation
	BBF2C	108230731	SNPQB4XAAB	Synchronous timing generator	TGS
	BBF4	106008089	SN3PGHFEAA	Synchronous timing generator	TG3
	BBG11B ‡	107486482	SNPQBMGAAA	Triple DS3	3DS3
	BBG12	106409170	SNPQAPSAAA	Triple STS1E	3STS1E
	BBG8B	107830549	SNC5U79DAB	System Controller	SYSCTL
	BCP3	106439219	SNPQA13AAA	Time Slot Interchange	TSI
	BCP4 §	107136574	SNC11V0AAA	Overhead controller	OHCTL
	21D-U	107092637	SNRXDJ0DAA	OC-3 Optical Line Interface Unit	OLIU
	21G3-U	108215484	SNRXDRPAAA	OC-3 Optical Line Interface Unit	OLIU
	23G-U †	107092652	SNRXDLAAAB	OC-12 Optical Line Interface Unit	OLIU
	23H-U **	107092660	SNRXDLBAAB	OC-12 1550 nm OLIU	OLIU
	177B	106634975	SNPQAFHAAB	Apparatus Blank (8")	APPBLK
	177C	106634983	SNPQAFJAAB	Apparatus Blank (12")	APPBLK

* Humans Equipment Catalog Item.

† Shipped with 0 dB SC buildout. See Table 8-10, Page 8-69 if other attenuators are needed. Requires 15 dB attenuation for loopback testing.

‡ Required in Release 5 to provide enhanced DS3 performance monitoring.

** Shipped with 0 dB SC buildout. See Table 8-10, Page 8-69 if other attenuators are needed. Requires 10 dB attenuation for loopback testing.

Table 8-12. DDM-2000 OC-12 Discontinued Availability (DA) Plug-Ins

DA Product Code	Comcode	DA Date	Replacement Code	Comcode
BBF2B	106995046	7/11/01	BBF2C	108230731
BBG5 SYSCTL	106633688	12/98	BBG5 SYSCTL	107822553 *
BBG8 SYSCTL	106008113	9/97	BBG8B SYSCTL	107830549
BCP1 OHCTL	106712730	4/99	BCP1 OHCTL	107822603 *
BCP2 TSI	106439193	4/99	BCP2 TSI	108000852 *
21G-U OLIU	107092645	1/98	21G3-U OLIU	108215484
21G2-U	107931628	11/01	21G3-U	108215484
23G OLIU	106409154	9/95	23G-U OLIU	107092652
23H OLIU	106971989	9/95	23H-U OLIU	107092660
23R-U RGN	107092678	8/99	No Replacement	N/A
21G2-U OLIU	107931628	2/00	21G3-U OLIU	108215484

* These replacement circuit packs are subject to availability through: Special Customer Operations (SCO), 1-888-900-EOLC, www.lucent-sco.com.

Miscellaneous Equipment and Tools

Although the DDM-2000 OC-12 Multiplexer was designed with built-in self-test capability for facilitating installation and normal maintenance routines and troubleshooting, certain ancillary equipment and tools may be useful to installers and maintenance personnel to aid in more sophisticated performance monitoring and testing. Table 8-13, Page 8-73; Table 8-14, Page 8-74; and Table 8-15, Page 8-75 list these items with recommended quantities per central office. Many of these items may already be a part of normal central office equipment.

Table 8-13. Miscellaneous Equipment and Tools

Description	COMCODE or Equipment Code	Minimum Quantities Recommended at CO	See Note	Qty. Ordered
Filter, Fan	ED-8C733-30, G5		11	
Tray, Fan (Spare Fan Pack)	ED-8C733-30, G6		12	
Front Cover Modification Kit, G1	847554185			
Replacement User Panel for G1 shelf	ED-8C727-31,G1			
Replacement User Panel for G4 shelf	ED-8C727-31,G2			

Table 8-14. Miscellaneous Fiber Cabling

Description	COMCODE or Equipment Code	Minimum Quantities Recommended at CO	See Note	Qty. Ordered
FS1EP-EP-2 Lightguide jumper *ST*®*II+-STII+* (2 ft.)	107149494	2	2,3	
FL1E-E-2 Lightguide jumper *ST-ST* (2 ft.)	105351795	2	2,3	
ST® Lightguide Buildout Assembly 0 dB (A3010) 5 dB (A3010B) 10 dB (A3010D) 15 dB (A3010F)	 106312523 106312556 106312572 106312598	 2	9	
4C Test cable (23H OLIU; 19 dB)	107089955	2	10	
Fiber Optic Cable *ST*-to-Biconic (4 feet)	105420913	2	14	

Table 8-15. Miscellaneous Accessories

Description	COMCODE or Equipment Code	Minimum Quantities Recommended at CO	See Note	Qty. Ordered
Craft interface terminal		1	1	
Strap, wrist > 6-1/2" circumference	408647824		4,5	
Terminal, ESD grounding	845264118		5	
Fuse, 10 amp	406203190		6	
Fuse Extraction Tool	406420273		6	
Modem			7	
Microduster Nozzle Assy with 10 oz. can, valve, and hose	406100321	1	8	
Microduster Air six 10 oz. refill cans	406852285		8	
Microduster Air twelve 10 oz. refill cans	406100339		8	
Absorbond Cleaner (Package) or equivalent	900709379	1	8	
Alcohol Squirt Bottle or equivalent	900726464	1	8	
Lint-free Pipe Cleaners (Package) or equivalent	403780570	1	8	
Connector Repair Kit, METRAL	106423858		13	
Double density edge card repair kit	106423502		13	
Duct Notching Tool		1	15	

Notes on Table 8-13, Page 8-73; Table 8-14, Page 8-74; and Table 8-15, Page 8-75:

1. A CIT is recommended for installation, maintenance, and administrative activities. A personal computer (PC) is required for software download and to run CPro-2000 software. The DDM-2000 OC-12 Multiplexer CIT port (mounted on the user panel) is a standard EIA-232-D (supersedes RS-232C specification) interface configured as DCE for direct connection to a CIT. The CIT port will support rates of 300, 1200, 2400, 4800, 9600, and 19,200 baud and should be compatible with most *ANSI* 3.64 ASCII terminals; however, it is optimized for standard CIT screens with display areas of 24 lines by 72 (or more) columns. A pager function is included in the DDM-2000 OC-12 Multiplexer to accommodate screen lengths from 3 lines to 150 lines.

   Those CITs compatible with DDM-1000 (see 363-206-100 for a list of DDM-1000 compatible terminals) should be directly compatible with the DDM-2000 OC-12 Multiplexer, although some may not be as convenient to use with the DDM-2000 OC-12 Multiplexer.

   If the multishelf bus cables (ED-8C724-20, G354 or G356) are connected between shelves in a bay, a CIT may then be connected to the user panel CIT port on any shelf and may address any other shelf in that bay (as well as the remote terminal shelves associated with that shelf in the bay). Any terminal compatible with the *ANSI* 3.64 standard should be compatible with the DDM-2000 OC-12 Multiplexer.

   See Section 11, "Technical Specifications," for PC specifications needed to run CPro-2000 software. The selected PC used for software download should have:

   - A minimum of 640K of random access memory (RAM)
   - *MS-DOS** version 2.0 or newer
   - Hard disk
   - At least one floppy disk drive of 360K or larger capacity. Although the disk drive may accommodate either floppy or hard disk, a hard disk is preferred for its better performance. The disk requirement is met with most portable *MS-DOS* PCs with a single 3.5-inch disk. An *MS-DOS* PC with a hard disk and either a 3.5-inch 1.44M floppy disk may also be used.

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* Registered trademark of Microsoft Corporation.

2. Equipment noted is not required for normal maintenance routines but may be helpful for installation and troubleshooting testing.
3. Lightguide jumpers noted are 2-foot cables with lightguide cable connectors that can be used for a manual optical loopback at the OLIU plug-in interface. See Note 9.
4. It is recommended that one wrist strap be provided for each DDM-2000 OC-12 bay arrangement for protection against plug-in damage resulting from electrostatic discharge.
5. Each DDM-2000 OC-12 shelf comes equipped with an ESD jack on the front panel for ESD wrist straps (see Note 4). ESD grounding terminals may be also mounted miscellaneously in unused #12-24 tapped holes in typical bay framework. If rear access activities are anticipated, at least one of these terminals is recommended for rear access bay mounting.
6. The two –48 V feeders (A and B) required for each DDM-2000 OC-12 shelf are protected by 10-amp fuses that ship with the shelf. It is recommended that a supply of spare fuses be provided at DDM-2000 OC-12 locations. Fuses and a fuse extraction tool can be ordered through Lucent Technologies using Comcode 406203190 for fuses and Comcode 406420273 for the extraction tool or through SAN-O Industrial Corporation, 91-3 Colin Drive, Sherwood Corporation Center, Holbrook, NY 11741 or by calling 516-472-6666 and ordering.

   Fuse, 10-amp, Part No. AX-1-10A or
   Fuse Extraction Tool, Part No. F-0431.

7. Where remote access is desired, an external modem may be furnished. Operation has been verified for AT&T models 4024 and 2296; however, many other manufacturers should also be compatible.
8. It is very important that optical fiber connections be cleaned thoroughly whenever they are removed and reconnected to avoid potential service-affecting optical losses. Consult the TOP section of 363-206-207, 363-206-290, or 363-206-295, *DDM-2000 OC-12 Multiplexer User/Service Manual (TOP)*, for proper cleaning procedures.
9. Loopback testing of the high speed OC-12 interface using the 23G-U OLIU requires 15 dB lightguide buildout assembly. See Table 8-16, Page 8-79.
10. Loopback testing of the high speed OC-12 interface using the 23H-U requires a 4C test cable that provides 19 dB of attenuation. For 23H-U OLIU lightguide buildout assemblies, see Table 8-17, Page 8-79.

11. Fan filters must be replaced when air flow is reduced to a preset value. An alarm is automatically generated when that value is reached. While the time interval between filter changes is a function of the relative cleanliness of the local air, typical intervals for similar equipment in the central office (CO) environment are 9 months. Since filters are stocked in Lucent Mdse., turnaround time should be less than two weeks; however it may be advisable to store some spares at the local level (perhaps 10 percent of the total number in use).

    NOTE:
    Do not rely on the filter alarm for filter replacement. A periodic maintenance program should be in place for the following reasons: 1) Some fans, i.e., cabinet fans, do not have filter sensors, 2) The sensor does not work when used in a multi-shelf configuration, 3) The sensor unit is unreliable as an indicator of the filter condition.

12. Spare fan packs needed for a given number of fan shelves are as follows:

    1 spare per 15 shelves
    2 spares per 48 shelves
    3 spares per 93 shelves
    4 spares per 143 shelves
    5 spares per 198 shelves
    6 spares per 258 shelves.

13. These repair kits are not required for normal maintenance routines, but should be available to installers and maintenance personnel.

    The METRAL Shelf Level Backplane Connector Repair Kit facilitates the repair of assembled METRAL backplanes. The kit provides the appropriate tools and instructions to remove and replace METRAL pins, blades and plastic housings after the backplane has been assembled to the shelf enclosure. This permits repair without backplane disassembly, allowing more efficient repairs.

    The double density edge card repair kit contains the specific tools required to correctly remove, identify, replace contact(s), insulators and bias slide/spring used in Double Density 1200 Type Assembled Connectors. The components in the kit are made from conductive materials and may not be used on equipment that is in the "powered-up" or operational condition.

14. Lightguide connectors at the OLIU plug-in interfaces are SC connectors. If interfaces to biconic entities are required for testing, the specified adapters or equivalent may be used.

15. Order from PANDUIT Corporation, Tinley Park, Illinois. Part number DNT-100.

Lightguide Buildout Guidelines

Table 8-16, Page 8-79 provides guidelines for selecting the proper OC-12 lightguide buildout for the 23G-U OLIU and 23R-U REGENR. Table 8-17, Page 8-79 provides guidelines for selecting the proper OC-12 lightguide buildout for the 23H and 23H-U OLIUs respectively.

Table 8-16. Lightguide Buildout Guidelines (23G-U and 23R-U)

Lightguide Buildout Loss (dB)	Minimum Facility Loss (dB)	Maximum Facility Loss (dB)	
		Controlled	Uncontrolled
0	10	23	19.5
5	5	18	14.5
10	0	13	9.5
15	0	8	4.5

To ensure proper operation (adequate power without receiver overload), the DDM-2000 OC-12 23G-U OLIU and OC-12 23R-U REGENR require a facility loss between 10.0 and 23.0/19.5 dB. (Maximum loss figures are quoted "A/B," where A is the maximum loss in controlled environments, and B is the uncontrolled environment specification.) Operation within this window of acceptable loss values is achieved by choosing the proper lightguide buildout.

For direct optical loopbacks, the 15 dB lightguide buildout should be used to ensure adequate loss for proper receiver operation. The optional 10 dB, 5 dB, and 0 dB lightguide buildout are used for progressively longer and higher-loss facilities. (Note that the 0 dB lightguide buildout is shipped as part of the 23G-U OLIU.)

For example, consider a loop application to an uncontrolled 80E cabinet, with 6 dB measured facility loss. The 10 dB lightguide buildout would be the best choice. The 15 dB lightguide buildout is not applicable above 4.5 dB facilities, while the 5 dB lightguide buildout is close to not providing enough loss (only 1 dB margin in terms of minimum loss). The 10 dB lightguide buildout creates an effective 16 dB facility loss, which positions this application in the middle of the 10-23 dB facility loss "window."

Table 8-17. Lightguide Buildout Guidelines (23H-U OLIU)

Lightguide Buildout Loss (dB)	Minimum Facility Loss (dB)	Maximum Facility Loss (dB) (Controlled Environment)
0	10	27.2
5	5	22.2
10	0	17.2

Lightguide Jumpers

To prevent potential degradations due to bandwidth limitations, the DDM-2000 OC-12 lightguide interface requires single-mode jumpers for connecting to and from the outside plant *LGX*® panel and the DDM-2000 OC-12 for all optical line interface units (OLIUs) except the 21D/21D-U OLIU. Single-mode (SM) jumpers are listed in Table 8-18, Page 8-80.

The 21D-U OLIU, used for intershelf OC-3/OC-12 interconnection, must use multimode (MM) jumpers on both transmit and receive sides. Multimode jumpers are listed in Table 8-19, Page 8-81.

For other types of lightguide jumpers contact your Lucent Technologies Account Executive.

Table 8-18. Single-Mode Lightguide Jumpers

Code	Comcode	Description	Length (Feet)	Connectors
FS1EP-EP-2	107149494	Lightguide Jumper	2	*ST*® *II+-STII+*
FS1EP-EP-10	107149536	Lightguide Jumper	10	*STII+-STII+*
FS1EP-EP-25	107149569	Lightguide Jumper	25	*STII+-STII+*
FS1EP-EP-50	107149601	Lightguide Jumper	50	*STII+-STII+*
FS1EP-EP-100	107149627	Lightguide Jumper	100	*STII+-STII+*
FS1E-A-2	105420905	Lightguide Jumper	2	*ST*-2016A Biconic
FS1E-A-10	105420947	Lightguide Jumper	10	*ST*-2016A Biconic
FS1E-A-25	105423958	Lightguide Jumper	25	*ST*-2016A Biconic
FS1E-A-50	105424006	Lightguide Jumper	50	*ST*-2016A Biconic
FS1E-A-100	105424022	Lightguide Jumper	100	*ST*-2016A Biconic
LS1SC-SC-2	106908247	Lightguide Jumper	2	SC-SC
LS1SC-SC-10	106908270	Lightguide Jumper	10	SC-SC
LS1SC-SC-25	106908304	Lightguide Jumper	25	SC-SC
LS1SC-SC-50	106908346	Lightguide Jumper	50	SC-SC
LS1SC-SC-100	106908395	Lightguide Jumper	100	SC-SC
LS1FP-FP-10	106593825	Lightguide Jumper	10	FCPC-FCPC
LS1FP-FP-25	106932908	Lightguide Jumper	25	FCPC-FCPC
LS1FP-FP-50	106932916	Lightguide Jumper	50	FCPC-FCPC
LS1FP-FP-100	106932924	Lightguide Jumper	100	FCPC-FCPC

Table 8-19. Multimode Lightguide Jumpers

Code	Comcode	Description	Length (Feet)	Connectors
FL1E-E-2	105351795	Lightguide Jumper	2	*ST*®-ST
FL1-EP-EP-04	107150161	Lightguide Jumper	4	*ST*® *II+-STII+*
FL1-EP-EP-10	107150195	Lightguide Jumper	10	*STII+-STII+*
FL1-EP-EP-25	107150229	Lightguide Jumper	25	*STII+-STII+*
FL1-EP-EP-50	107150260	Lightguide Jumper	50	*STII+-STII+*
FL1-EP-EP-100	107150286	Lightguide Jumper	100	*STII+-STII+*
FL1E-A-2	105613954	Lightguide Jumper	2	*ST*-2016A Biconic
FL1E-A-10	105613988	Lightguide Jumper	10	*ST*-2016A Biconic
FL1E-A-25	105614010	Lightguide Jumper	25	*ST*-2016A Biconic
FL1E-A-50	105614051	Lightguide Jumper	50	*ST*-2016A Biconic
FL1E-A-100	105614119	Lightguide Jumper	100	*ST*-2016A Biconic
LL1SC-SC-2	106908668	Lightguide Jumper	2	SC-SC
LL1SC-SC-10	106908692	Lightguide Jumper	10	SC-SC
LL1SC-SC-25	106908734	Lightguide Jumper	25	SC-SC
LL1SC-SC-50	106908775	Lightguide Jumper	50	SC-SC
LL1SC-SC-100	10690879	Lightguide Jumper	100	SC-SC
LL1FC-FC-10	107095549	Lightguide Jumper	10	FC-FC
LL1FC-FC-25	107095556	Lightguide Jumper	25	FC-FC
LL1FC-FC-50	107095564	Lightguide Jumper	50	FC-FC
LL1FC-FC-100	107095572	Lightguide Jumper	100	FC-FC

Product Support

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Product Support

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Overview

This section describes how Lucent Technologies supports the DDM-2000 Multiplexers. This includes technical support, engineering and installation services, documentation support, and training.

Customer Technical Support (CTS)

Customer Technical Support is available through a toll free technical assistance number. Lucent maintains a highly-skilled, multi-tier support structure consisting of regional engineers, product specialists, and system designers to support your network equipment. All levels of technical expertise may be called upon to solve the customer problem.

The Customer Technical Support organization provides remote, diagnostic support. On-site assistance is available on a billable contract or time & material basis. Support services may include the following activities:

- Responding to all requests for assistance
- Tracking and maintaining visible ownership of all reported problems, from inception through resolution
- Analyzing and diagnosing reported problems
- Providing restoration and recovery service
- Providing preventive and/or circumvention measures

- Communicating the actions, plans, and problem status to the reporting customer
- Initiating action to establish Modification Requests (MRs) for design issues
- Writing and distributing technical bulletins (Urgent Problem Notification)

Customer Technical Support services are available on a contract basis in three levels to meet varying customer needs: Preferred, Standard, and Basic Agreements. The Preferred level of support guarantees 24 x 7 (24 hour, 7 day-a-week) coverage of the customer's network. Guaranteed performance commitments for response, service restoration, and problem resolution times are validated by published Service Performance Reports. The Standard level of support guarantees 8 x 5 (8 hour, 5 day-a-week) coverage. Performance commitments are also validated by Service Performance Reports. Out-of-hours support is available for an additional fee. The Basic level of support guarantees 8 x 5 coverage with hourly billing for each support call. Out-of-hours coverage is available with additional fees.

When the customer experiences a problem, the initial point of contact within Lucent is the Regional Technical Assistance Center (RTAC). RTAC is divided into three regions covering North America: region East (includes Canada), region South, and region West. They can be reached by calling 1-800-CAL-RTAC (1-800-225-7822). Lucent works with the customer to define the problem and determine its severity. Problems are worked during the customer's contracted coverage period. By prior agreement, service-affecting problems are worked immediately regardless of contracted coverage with billing reconciliation if required. Acting as a single point of contact with the customer, the RTAC engineer will involve all necessary tiers of support to solve the customer problem.

The RTAC and CTS organization strive to provide proactive and responsive technical customer support for all its products. Through the combined efforts of the individual customer support groups, the RTAC and CTS organization provide the best possible customer support.

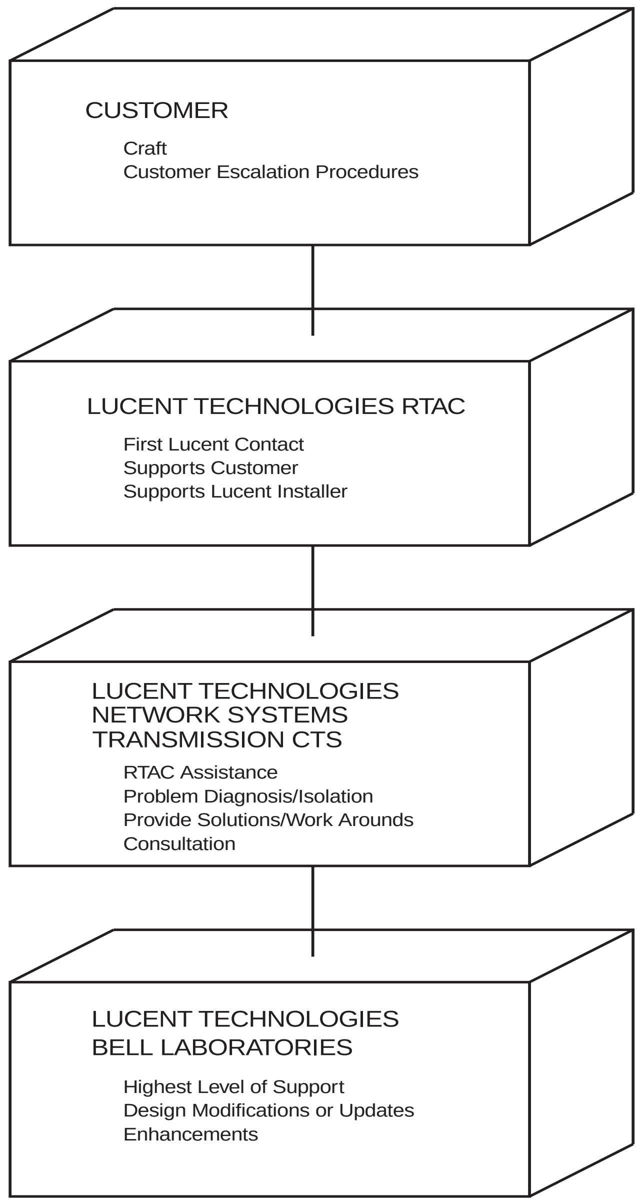

Figure 9-1. Product Support

Engineering and Installation Services

The Lucent Technologies Customer Support and Operations (CS&O) organization provides customers with quality product support services. Whether you need assistance in engineering, installation, normal system maintenance, or disaster recovery, the support staff provides you with the quality technical support you need to get your job done. Each segment of the CS&O organization regards the customer as its highest priority and understands your obligation to maintain quality service for your customer.

Within the CS&O organization, the Engineering and Installation Services group provides a highly skilled force of support personnel to provide customers with quality engineering and installation services. These engineering and installation specialists use state-of-the-art technology, equipment, and procedures to provide customers with highly competent, rapid response services. These services include analyzing your equipment request, preparing a detailed specification for manufacturing and installation, creating and maintaining job records, installing the equipment, and testing and turning over a working system.

When the CS&O organization provides job records and installs the equipment, operationally affective changes to the system are automatically identified and applied to the system at no additional cost.

The Engineering and Installation Services group provides the customer with an individually tailored, quality-tested job that meets our published high standards and the customer's operational requirements. The group ensures that the customer's system order is integrated into a complete working system tailored to office conditions and preferences. This process provides for the customer's complete needs. It includes provisions for cabling, lighting, power equipment, and ancillary connections to local and/or remote alarm systems. The group will also respond to any customer changes that occur during installation.

All equipment engineered and installed by Lucent is thoroughly tested and integrated into a reliable system at cutover. Once approved by Lucent's Quality Assurance Test group, the system is turned over to the customer.

The group also provides any specialized engineering and installation services required for unusual or highly individualized applications. These services may include engineering consultations and database preparation. Your local Lucent Technologies Account Executive can provide more information about these services.

Customer Technical Support Enhanced Services

The goal of Lucent Technologies' Customer Technical Support Enhanced Services is to keep Lucent Transmission Systems products operating at maximum performance and to prevent problems from interrupting service to customers.

Typical Enhanced Services include:

- Network design, growth planning, and performance analysis
- Multivendor troubleshooting
- Network Integration
- Preventive and remedial maintenance
- Hardware and software upgrade services
- On site maintenance programs.
- Customized MOP (Method of Procedure) development.

For more information on Lucent's Customer Technical Support Services, contact your Lucent Technologies Account Executive.

Documentation Support

The Lucent Technologies Customer Training and Information Products organization provides a contact to report errors or to ask questions about information in this document. The document support telephone number is **1-800-645-6759** (Monday through Friday, 8:00 a.m. to 4:00 p.m. EST).

Related Training

The Customer Training and Information Products Centers at Altamonte Springs, Florida, and Lisle, Illinois, provides management courses for planning, engineering, and ordering, as well as training for telecommunications technicians in installation, operations, and maintenance. Suitcasing of these courses is available. Consult your local Lucent Technologies Account Executive for more information or reservations.

Call **1-888-LUCENT8 (1-888-582-3688), prompt 2** for enrollment.

The following courses are provided by the National Product Training Center:

- Number: LW2211 (CD-ROM)

  Title: DDM-2000 OC-3/OC-12 Multiplexer Fundamentals

  Audience: This is a CD-ROM based course for anyone interested in learning the fundamentals of operation of the DDM-2000 OC-3 and OC-12 Multiplexers.

  Content: General information about the DDM-2000 OC-3 and OC-12 Multiplexers, including a product overview, applications, and architecture.

- Number: LW2212

  Title: DDM-2000 OC-3 and OC-12 Application, Architecture, and Ordering

  Audience: Fundamental planners, current planners, account executives, and private telecommunications network technical consultants.

  Content: General information about the DDM-2000 OC-3 and OC-12 Multiplexers including a product overview, applications, architecture, and deployment planning.

- Number: LW2604

  Title: DDM-2000 OC-3 Multiplexer Ring/Linear Networks, Operations and Maintenance

  Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in day-to-day provisioning and maintenance.

  Content: Information supporting operations, maintenance, and provisioning of ring and/or linear DDM-2000 OC-3 Multiplexers. On-site shelves are used for extensive hands-on experience.

- Number: LW2610

  Title: DDM-2000 FiberReach Wideband Shelf, Operations and Maintenance

  Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in DDM-2000 FiberReach network functions.

  Prerequisite: LW2212

  Content: Information supporting operations, maintenance, and provisioning of DDM-2000 FiberReach Wideband Shelf. On-site shelves are used for extensive hands-on experience.

- Number: LW2611

  Title: DDM-2000 FiberReach Multiplexer Self-Paced Course

  Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in DDM-2000 FiberReach network functions.

  Prerequisite: LW2212

  Content: Information supporting system engineering and planning, applications, operations, maintenance, and provisioning of DDM-2000 FiberReach networks.

- Number: LW2612

  Title: DDM-2000 OC-12 Multiplexer Operations and Maintenance

  Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in day-to-day provisioning and maintenance.

  Content: Information supporting operations, maintenance, and provisioning of the DDM-2000 OC-12 Multiplexer. Includes information on DDM-2000 OC-12 linear and ring applications. On-site shelves are used for extensive hands-on experience.

- Number: LW2614

  Title: 2000 Product Family Surveillance and Performance Monitoring

  Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in day-to-day provisioning and maintenance

  Content: Information supporting operations interfaces using X.25 links to an operations center

- Number: LW2618

  Title: Advanced Ring Network Applications, Operations, and Maintenance

  Audience: Technicians, supervisors, maintenance engineers, and operation support personnel involved in day-to-day operations of FT-2000 and/or DDM-2000 OC-3/OC-12 rings having dual ring interworking (DRI) traffic.

  Prerequisites: LW2616

  Content: Information supporting operations, maintenance, and provisioning of DRI networks. On-site shelves are used for extensive hands-on experience.

Reliability and Quality

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10 Reliability and Quality

Overview

This section provides the Lucent Technologies' quality policy, describes the reliability program, and describes the International Standards Organization (ISO) certification awarded to Lucent Technologies' Transmission Business Unit.

Introduction

POLICY—Quality excellence is the foundation for the management of our business and the keystone of our goal of customer satisfaction. It is, therefore, our policy to:

- Consistently provide products and services that meet the quality expectations of our customers.
- Actively pursue ever-improving quality through programs that enable each employee to do his or her job right the first time.

—Richard A. McGinn, Chairman and CEO

This Lucent Technologies Quality Policy guided the development of the DDM-2000 Multiplexers and will continue affecting this product throughout its lifetime. The primary tool ensuring product quality is the Quality Plan, used with the Lucent Technologies Transmission Systems Reliability Program.

Reliability Program

Reliability is a key ingredient of the product life cycle, beginning at the earliest planning stage. Major efforts at the start of the project were system reliability modeling, creating the project quality team (with representatives of all major activity areas), and writing and imposing the quality plan. A key part of the quality plan is the reliability plan.

During the design and developmental stage, reliability predictions, qualification and selection of components, definition of quality assurance audit standards, and prototyping of critical areas of the system ensured built-in reliability.

During manufacturing and field deployment, techniques such as premanufacturing, qualification, production quality tracking, failure mode analysis, and feedback and correction further enhance the ongoing reliability of the DDM-2000 Multiplexers.

Detailed reliability specifications for the DDM-2000 Multiplexers are included in Section 11, "Technical Specifications" section, of this document.

International Standards Organization (ISO) Certification

Lucent Technologies’ Transmission Systems Business Unit received ISO 9001 certification for its Merrimack Valley manufacturing facility and associated development organization on September 15, 1992. Merrimack Valley manufactures systems for transporting data, voice, and images over public and private telecommunications networks. Major product lines consist of digital access and cross-connect systems, network multiplex systems, and lightwave systems.

ISO 9001 is an international quality standard recognized by more than 50 countries. ISO 9001 is the most comprehensive standard in the ISO 9000 series, requiring well documented and implemented controls for design development, production, delivery, installation, and service. Its purpose is to ensure manufacturers produce products with consistently high levels of quality and service.

Technical Specifications

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Technical Specifications 11

Overview

This section contains the technical specifications for the DDM-2000 OC-3 Multiplexer, the DDM-2000 OC-12 Multiplexer, and the OC-12 Regenerator.

DDM 2000 OC-3 Multiplexer

External Transmission Interfaces

The DDM-2000 OC-3 Multiplexer transmission interfaces adhere to industry standards as listed in Table 11-1.

.

Table 11-1. Transmission Interface Standards

Interface	Standard	Comments
DS1 low-speed	CB-119, *ANSI* * T1.102-1993	B8ZS/AMI option
	TR-499, Iss. 5, *ANSI* T1.403-1989	SF, ESF
DS3 low-speed	CB-119, *ANSI* T1.102-1993, TR-499, Iss. 5	VMR, VM, or clear channel
OC-1/OC-3/OC-12	*ANSI* T1.106/88, *ANSI* T1.105/91 TR-253, Iss. 2, TR-496, Iss. 3	
EC-1	*ANSI* T1.102-1993, & TR-253, Iss. 2	

* Registered trademark of American National Standards Institute.

Electrical Interfaces

The DDM-2000 OC-3 Multiplexer supports DS1 electrical, DS3 electrical, and EC-1 electrical high-speed and low-speed interfaces.

DS1 Low-Speed (BBF1B)

- Electrical Specification

  The DS1 low-speed interface transmits and receives a standard electrical DS1 signal as specified in *ANSI* * T1.102-1993, Section 2 (1.544 Mb/s nominal rate, DSX-1 interconnect specification). Line coding is provisionable to alternate mark inversion (AMI) with or without bipolar 8-zero substitution (B8ZS). Line buildout is provisionable as follows:

  - 613C (22 gauge): 30 to 655 ft.
  - 1249-C (26 gauge): 30 to 450 ft.

- Format Specification

  The DS1 low-speed interface provides clear channel transport of any DSX-1 compatible signal. There are no format constraints on this interface.

- Alarm Thresholding

  The following parameters are monitored at the DS1 interface:

  - Loss of signal (LOS)
  - Line coding violations (CV-L)

- Loopback

  - Quad DS1 facility loopback.

The alarm level for each of the monitored parameters can be provisioned to critical (CR), major (MJ), minor (MN), or status. B8ZS and AMI coding violation failure thresholds are user settable to 10^{-3} or 10^{-6} and in addition for Release 8.0 and later releases 10^{-7} or 10^{-8} BER.

* Registered trademark of American National Standards Institute.

DS1PM Low-Speed (BBF3/BBF3B)

- Electrical Specification

  The DS1PM low-speed interface transmits and receives a standard electrical DS1 signal as specified in *ANSI* T1.102-1993, Section 2 (1.544 Mb/s nominal rate, DSX-1 interconnect specification). Line coding is provisionable to AMI with or without B8ZS. Line buildout is provisionable as follows:

  — 613C (22 gauge): 30 to 655 ft.

  — 1249-C (26 gauge): 30 to 450 ft.

- Format Specification

  The DS1PM low-speed interface can be provisioned for the following DS1 formats: clear channel (default), superframe (SF) as specified in *ANSI* T1.403-1989, or extended superframe (ESF) as specified in *ANSI* T1.403-1989. In the case of SF or ESF format selections, DS1 performance information is collected by monitoring the associated DS1 framing format.

- Alarm Thresholding

  The following parameters are monitored at the DS1PM interface:

  — Loss of signal (LOS)

  — Line coding violations (CV-L).

The alarm level for each of the monitored parameters can be provisioned to CR, MJ, MN, or status. B8ZS and AMI coding violation failure thresholds are user settable to 10^{-3} or 10^{-6} and in Release 8.0 and later releases 10^{-7} or 10^{-8} BER.

- Loopback

  — Quad DS1 facility loopback (BBF3)

  — Single DS1 facility loopback (BBF3B) (Release 13.0 and later).

- Performance Monitoring (see Table 11-22)

  DS1 Path Parameters:

  — Errored Seconds (ES-P)

  — Severely Errored Second (SES-P)

  — Unavailable Seconds (UAS)

  — CV-P Coding Violations (Release 7.2 and later)

  — CV-PFE Coding Violations (Release 7.2 and later)

  DS1 Line Parameters:

  — ES-L Errored Seconds (Release 7.2 and later)

T1 Carrier Low-Speed (BBF6 T1EXT)

- Electrical Specification

  The T1 carrier low-speed interface (T1EXT) transmits and receives a standard electrical T1 carrier signal as specified in CB No. 113, Issue 2, April 1978. The T1EXT supports two interfaces. Line coding is provisionable to AMI with or without B8ZS. The following are specifications for the driver/receiver:

  — Driver Output: 3 V peak pulse

  — Receiver Gain: 35 dB maximum at 772 KH

  — Receiver Dynamic Range: 0 to 35 dB (no pad at input).

  The driver/receiver does not require any special provisioning to support up to 6,000 feet of 22-gauge copper cable (at 22 degrees Celsius) used in a T-Carrier system.

  The T1EXT will support a single span of the following distances:

  — In a central office: up to 3000 feet (±1500 feet)

  — In an outside plant cabinet or wall DT: up to 6,000 feet.

  The 60 mA constant current regulator will support a simplex loop resistance of 221 ohms.

  — The T1EXT does not support fault locating using bipolar violations

  — The T1EXT can interface with "looping regulator" type repeaters only

  — The T1EXT does not have the capability to loop the simplex current back to a T1 line repeater

  — The T1EXT does not include any components for primary or secondary lightning protection/surge protection or power cross. Primary protection (Lucent Technologies' protector unit 4B3EW or equivalent) is always required for tip/ring lines exposed to lightning and surges either in cabinet or as lines enter a building. An external secondary lightning and surge protection assembly (ED-8C783) must be collocated with the FiberReach shelf for all outside plant applications. Refer to Figure 11-1 for T1EXT span powering.

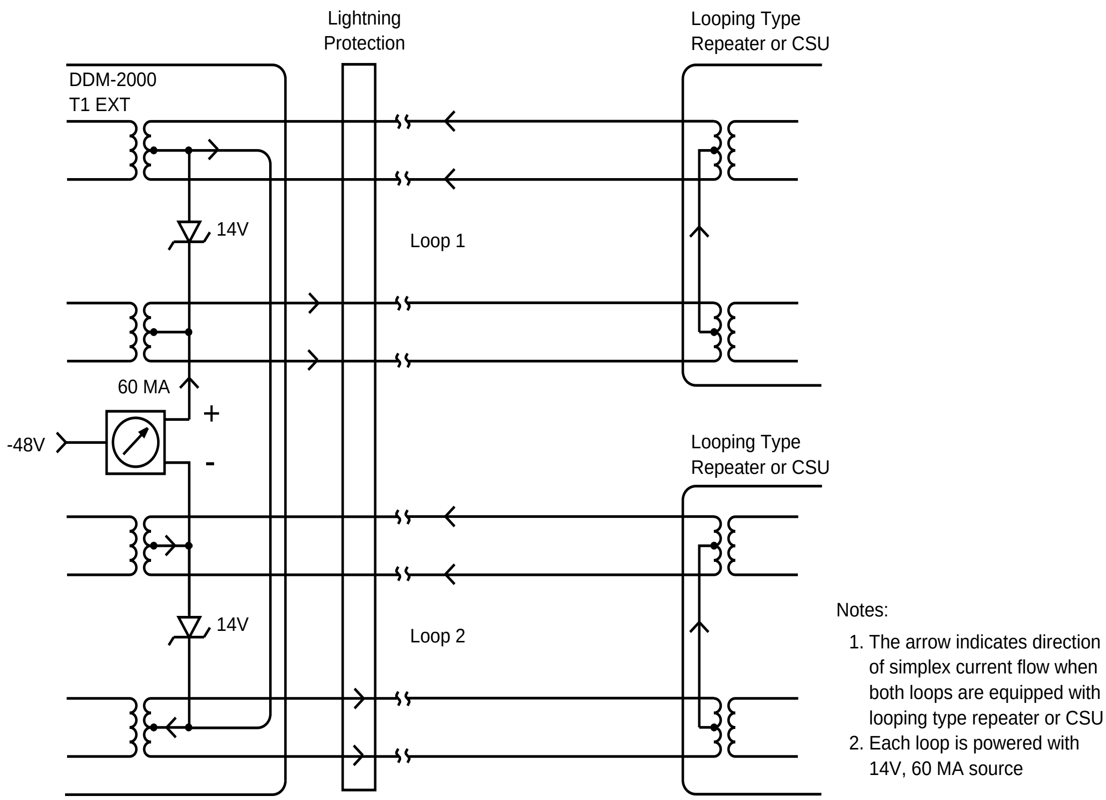

Figure 11-1. **T1EXT Span Powering**

- Format Specification

  The T1EXT BBF6 low-speed interface can be provisioned for the following formats: clear channel (default), SF as specified in *ANSI* T1.403-1989, or ESF as specified in *ANSI* T1.403-1989. In the case of SF or ESF format selections, T1EXT performance information is collected by monitoring the associated T1EXT framing format.

- Alarm Thresholding

  The following parameters are monitored at the T1EXT interface:

  — Loss of signal

  — Line coding violations.

  The alarm level for each of the monitored parameters can be provisioned to CR, MJ, MN, or status. B8ZS and AMI coding violation failure thresholds are user settable to 10^{-3}, 10^{-6}, 10^{-7}, or 10^{-8} BER.

- Performance Monitoring (PM) (see Table 11-22)

  — Near-end T1EXT path parameters (ES, SES, and UAS) for SF or ESF framed signals incoming to the DSX-1

  — Far-end T1EXT path parameters (ES, SES, and UAS) for ESF framed signals using performance report messages (PRM) incoming from the DSX-1.

  — Coding violations (CV) for near-end and far-end

  — T1EXT line PM monitoring and ES reporting

LAN Interface (BBF9)

- Electrical Specification:

  The BBF9 LAN circuit pack provides a single 10/100BaseT, IEEE 802.3 compliant interface. The LAN port performs protocol transparent filtering and bridging of incoming MAC frames. MAC frames with a destination address on the local bus are filtered by the BBF9 to prevent unnecessary transmission of frames over the wide area network (WAN). The LAN interface autonegotiates mode (full/half duplex) and speed (10/100 Mb/s) when interfacing with other 802.3 compliant devices over twisted pair media. The circuit pack occupies two adjacent low-speed slots and uses from one to 8 DS1 signals to provide native mode LAN transport through a SONET WAN.

- LAN port:
  - 10/100BaseT IEEE 802.3 compliant
  - RJ-45 faceplate connector
  - Cat-3 or CAT-5 UTP (unshielded twisted pair) medium
  - Buffering .5 MByte for each direction
  - See Table 11-2 for electrical and optical characteristics.

- Format Specification:

  The LAN interface converts incoming MAC frames to an ATM cell format using ATM adaptation layer 5 (AAL5) encapsulation as specified in IETF RFC-1483. ATM cells are distributed in round robin order on 1 to 8 ESF formatted DS1 signals using the ATM forum IMA Specification Version 1.1 for inverse multiplexing. The DS1 signals are mapped into asynchronous VT1.5 signals for transport through a SONET network. The circuit pack can compensate for up to 50 ms of differential delay among the 8 DS1s and uses a single IMA group with one ATM virtual channel (VC). The following provisioning options are provided:
  - AAL5 Protocol - VC multiplex or LLC encapsulation (Bridged)
  - MAC Frame Check Sequence (FCS) Preservation - enable or disable
  - ATM Virtual Path ID and Virtual Channel ID
  - IMA group ID
  - IMA Frame Length - 32, 64, 128, 256
  - ATM scrambler - on/off
  - ATM polynomial - on/off.

  The IMA link IDs are assigned automatically by the system in the range 0 to 7. The IMA protocol operates in symmetric configuration with common clock.

- Alarms:

  Local LAN port failures are detected by monitoring for the presence of either MAC frames or Link Pulses per IEEE 802.3. From the SONET direction, failures are detected by monitoring for VT1.5 (AIS, LOP), DS1 LOF, Loss of IMA frame, Loss of IMA Delay Synchronization (LODS), Loss of Cell Delineation (LCD) and excessive AAL5 CRC errors. The alarm level for a local LAN port failure is user provisionable (Major, Minor, Not Alarmed).

- Performance Monitoring:

  In addition to DS1 and VT1.5 path performance monitoring, the BBF9 circuit pack supports performance monitoring of data flow in both directions. The parameters supported are:

  — Transmit MAC packets forwarded (towards the WAN)

  — Transmit MAC packets discarded

  — Receive MAC packets forwarded (towards the LAN)

  — Receive MAC packets discarded.

  In addition, to monitor the efficiency of the IMA link the following parameters are supported:

  — Transmit ATM cells total

  — Transmit ATM idle cells

  — Receive ATM cells total

  — Received ATM cells Idle.

LAN Interface (BBF10)

- Electrical Specification:

  The BBF10 LAN circuit pack provides a single 100BaseFX, IEEE 802.3 compliant interface. The LAN port performs protocol transparent filtering and bridging of incoming MAC frames. MAC frames with a destination address on the local bus are filtered by the BBF10 to prevent unnecessary transmission of frames over the wide area network (WAN). The LAN interface autonegotiates mode (full/half duplex) and speed (100 Mb/s) when interfacing with other 802.3 compliant devices over twisted pair media. The circuit pack occupies two adjacent low-speed slots and converts an optical signal to from one to 8 DS1 signals to provide native mode LAN transport through a SONET WAN.

- LAN port:
  - 100BaseFX IEEE 802.3 compliant
  - SC optical connector
  - 1300 nm nominal center wavelength
  - 62.5 micron multimode fiber
  - Buffering .5 MByte for each direction
  - See Table 11-2 for electrical and optical characteristics.

- Format Specification:

  The LAN interface converts incoming MAC frames to an ATM cell format using ATM adaptation layer 5 (AAL5) encapsulation as specified in IETF RFC-1483. ATM cells are distributed in round robin order on 1 to 8 ESF formatted DS1 signals using the ATM forum IMA Specification Version 1.1 for inverse multiplexing. The DS1 signals are mapped into asynchronous VT1.5 signals for transport through a SONET network. The circuit pack can compensate for up to 50 ms of differential delay among the 8 DS1s and uses a single IMA group with one ATM virtual channel (VC). The following provisioning options are provided:
  - AAL5 Protocol - VC multiplex or LLC encapsulation (Bridged)
  - MAC Frame Check Sequence (FCS) Preservation - enable or disable
  - ATM Virtual Path ID and Virtual Channel ID
  - IMA group ID
  - IMA Frame Length - 32, 64, 128, 256
  - ATM scrambler - on/off
  - ATM polynomial - on/off.

The IMA link IDs are assigned automatically by the system in the range 0 to 7. The IMA protocol operates in symmetric configuration with common clock.

- Alarms:

  Local LAN port failures are detected by monitoring for the presence of either MAC frames or Link Pulses per IEEE 802.3. From the SONET direction, failures are detected by monitoring for VT1.5 (AIS, LOP), DS1 LOF, Loss of IMA frame, Loss of IMA Delay Synchronization (LODS), Loss of Cell Delineation (LCD) and excessive AAL5 CRC errors. The alarm level for a local LAN port failure is user provisionable (Major, Minor, Not Alarmed).

- Performance Monitoring:

  In addition to DS1 and VT1.5 path performance monitoring, the BBF10 circuit pack supports performance monitoring of data flow in both directions. The parameters supported are:

  — Transmit MAC packets forwarded (towards the WAN)

  — Transmit MAC packets discarded

  — Receive MAC packets forwarded (towards the LAN)

  — Receive MAC packets discarded.

  In addition, to monitor the efficiency of the IMA link the following parameters are supported:

  — Transmit ATM cells total

  — Transmit ATM idle cells

  — Receive ATM cells total

  — Received ATM cells Idle.

Table 11-2. BBF9 and BBF10 LAN Optical and Electrical Characteristics

Receiver Parameters	Symbol	Min.	Typical	Max.	Unit
Input Optical Power (Minimum at Window Edge)	$P_{IN\ Min.}$ (W)		–33.5	–31.0	dBm avg.
Input Optical Power (Minimum at Eye Center)	$P_{IN\ Min.}$ (C)		–34.5	–31.8	dBm avg.
Input Optical Power Maximum	$P_{IN\ Max.}$	–14.0	–11.8		dBm avg.
Operating Wavelength	λ	1270		1380	nm
Signal Detect - Asserted	P_A	P_D + 1.5 dB		–33.0	dBm avg.
Signal Detect - De-asserted	P_D	–45.0			dBm avg.
Signal Detect - Hysteresis	P_A - P_D	1.5	2.4		dB
Signal Detect Assert Time (off to on)	AS_Max	0	2	100	µs
Signal Detect De-assert Time (on to off)	ANS_Max	0	5	350	µs
Transmitter Parameters	**Symbol**	**Min.**	**Typical**	**Max.**	**Unit**
Output Optical Power BOL 62.5/125 µm, NA=0.275 Fiber EOL	P_O	–19.0 –20.0	–15.7	–14.0	dBm avg.
Output Optical Power BOL 50/125 µm, NA=0.20 Fiber EOL	P_O	–22.5 –23.5	–20.3	–14.0	dBm avg.
Optical Extinction Ratio			0.05 –50.0	0.2 –35.0	% dB
Output Optical Power at Logic Low “0” State	P_O(“0”)			–45.0	dBm avg.
Center Wavelength	λ_C	1270	1308	1380	nm
Spectral Width - FWHM -RMS	$\Delta\lambda$		147 63		nm

HDSL Interface (BBF8)

- Electrical Specification

  The High bit rate Digital Subscriber Line (HDSL) circuit pack transmits and receives a 2B1Q signal as specified in Telcordia Technologies TA-NWT-001210.

  — Data is scrambled/descrambled with a pseudo-random sequence

  — Line buildout is automatically provisioned

  — Compensated for data inversion caused by tip-ring reversals

- Format Specification

  The HDSL allows for clear channel transport of a framed or unframed DS1. Its data stream consists of two 784 Kb/s signals transported on separate wire pairs. Together, the aggregate bi-directional bit rate is 1.544 Mb/s. The remaining 24 Kb/s is used for training and diagnostic information.

  — Compatible with PairGain™ equipment

- Alarm reporting

  — LOS

  A LOS is reported if either HDSL line experiences a synchronization failure

- Loopback

  DS1 terminal loopback for each HDSL interface

- Performance Monitoring (PM) — Available through the HDSL link management port only.

  — User-configurable alarm thresholds

  — 15-minute, 24-hour, and 7-day performance histories

  — Asynchronous serial interface for provisioning and PM

- Management

  — SONET Management

  This link is accessible via the SONET DCC and DDM-2000 CIT. It allows the HDSL circuit pack to be provisioned for DS1 facility loopbacks.

  — HDSL Link Management

  This link is accessible via a faceplate mounted RS-232 interface. It allows management of each HDSL port only (management of the DDM-2000 is not accessible through this interface). This management port supports a menu driven interface for each HDSL port; managed features include:

  — PM features listed above

  — Local and remote loopbacks

— Programmable loopback time-out

— Alarm status.

DS3 Low-Speed (BBG4/4B)

- Electrical Specification

  The low-speed DS3 interface transmits/receives a standard electrical DS3 signal as specified in *ANSI* T1.102-1993, Section 5 [44.736 Mb/s rate, DSX-3 interconnect specification, bipolar 3-zero substitution (B3ZS) encoding]. However, the signal does not have to contain a standard DS3 frame.

  Line buildout is provisionable as follows:

  — 734A/D: 0 to 450 ft.

  — 735A: 0 to 250 ft.

- Format Specification

  The DS3 low-speed interface provides clear channel transport of any DSX-3 compatible signal (M13 mode, framed clear channel, unframed clear channel). Thus, there are no format requirements on this interface.

- Alarm Thresholding

  The following parameters are monitored at the DS3 interface to the DSX-3:

  — Loss of signal (LOS)

  — Line coding violations (CV-L).

  The alarm level for each of the monitored parameters can be provisioned to CR, MJ, MN, or status. B3ZS coding violation failure threshold is user settable to 10^{-3} or 10^{-6} BER.

- Performance Monitoring (see Table 11-22)

  — DS3 parity errors (P-Bits)

  — Severely errored frame seconds (SEFS).

  If provisioned in the violation monitor and removal (VMR) or violation monitor (VM) modes (Table 11-3), DS3 P-bit violations and SESF are counted and the counts are thresholded to flag detected performance degradation of the DS3 signal incoming from the fiber.

Table 11-3. DS3 Interface Modes

	Monitor P-Bits	Correct P-Bits
VMR mode	Yes	Yes
VM mode	Yes	No
CC mode	No	No

- Enhanced DS3 Performance Monitoring (see Table 11-22)
  - CV-P Coding Violations

    These errors are counted and thresholded independently for all DS3 interfaces provisioned in VM or VMR mode. When the F&M bit or C-bit option (C-bit is Release 8.0 and later releases) is selected, network elements could be provisioned in VMR or VM mode. See Table 11-4.
  - Errored Seconds (ES-P)
  - Severely Errored Seconds (SES-P)
  - Unavailable Seconds (UAS-P)
  - Severely Errored Frame Seconds (SEFS)
  - CV-L Coding Violations Line (Release 7.2 and later)
  - ES-L Errored Seconds (Release 7.2 and later)
  - SES-L Severely Errored Seconds Line (Release 7.2 and later)

Table 11-4. Enhanced DS3 Performance Monitoring Modes

Mode	PM Option	Monitor P-Bits	Monitor F&M Bits	Monitor C-Bits	Correct P-Bits	Correct F&M Bits	Correct C-Bits	Monitor Line PM
VMR	P-bit	Yes	No	No	Yes	No	No	Yes
VMR	F&M-bit	No	Yes	No	Yes	No	No	Yes
VMR	C-bit	No	No	Yes	Yes	No	No	Yes
VM	P-bit	Yes	No	No	No	No	No	Yes
VM	F&M-bit	No	Yes	No	No	No	No	Yes
VM	C-bit	No	No	Yes	No	No	No	Yes
CC	P-bit	No	No	No	No	No	No	Yes
CC	F&M-bit	No	No	No	No	No	No	Yes
CC	C-bit	No	No	No	No	No	No	Yes

EC-1 High-Speed and Low-Speed (BBG6)

- Electrical Specification

  The EC-1 high-speed and low-speed interface transmits and receives a standard electrical EC-1 signal as specified in *ANSI* T1.102-1993 (51.844 Mb/s rate, STSX-1 interconnect specification, bipolar 3-zero substitution ([B3ZS] encoded and scrambled).

  Line buildout is provisionable as follows:

  — 734A/D: 0 to 450 ft.

  — 735A: 0 to 250 ft.

- Format Specification

  The EC-1 high-speed port interfaces with an EC-1 signal compatible with the electrical STS-1 interface specification in *ANSI* T1.102 and containing a VT1.5 structured STS-1 with an asynchronous DS1 mapping. The EC-1 high-speed interface provides both line and STS-1 path termination functions.

  The EC-1 low-speed interface provides clear channel transport of any STS-1 signal compatible with the electrical STS-1 interface specification in *ANSI* T1.102. The EC-1 low-speed port can be provisioned to provide the path termination functions for a VT1.5 structured STS-1 with an asynchronous DS1 mapping.

- Alarm Thresholding

  The following parameters are monitored at the EC-1 interface to the STSX-1:

  — Loss of signal (LOS)

  — Loss of frame (LOF)

  — Loss of pointer (LOP)

  — Line alarm indication signal (AIS)

  — B2 thresholding signal fail

  — B2 thresholding signal degrade.

  The alarm level for each of the monitored parameters can be provisioned for CR, MJ, MN, or status. B2 signal degrade thresholds are user settable in the range from 10^{-6} to 10^{-9} BER.

- Performance Monitoring (see Table 11-22)

  — EC-1 line performance monitoring.

DS3 Data Services Interface (BBG19)

- Electrical Specification

  The low-speed DS3 interface transmits/receives a standard electrical DS3 signal as specified in *ANSI* T1.102-1993, Section 5 (44.736 Mb/s rate, DSX-3 interconnect specification, bipolar 3-zero substitution [B3ZS] encoding). However, the signal does not have to contain a standard DS3 frame.

  LBO is provisionable as follows:

  — 734A/D: 0 to 450 ft.

  — 735A: 0 to 250 ft.

- Format Specification

  The DS3 low-speed interface provides clear channel transport of any DSX-3 compatible signal (M13 mode, framed clear channel, unframed clear channel). Thus, there are no format requirements on this interface.

- Alarm Thresholding

  The following parameters are monitored at the DS3 interface to the DSX-3:

  — LOS

  — CV-L.

  The alarm level for each of the monitored parameters can be provisioned to CR, MJ, MN, or status. B3ZS coding violation failure threshold is user settable to 10^{-3} or 10^{-6} BER.

- Performance Monitoring (see Table 11-22)

  — DS3 parity errors (P-Bits)

  — SEFS.

  If provisioned in the VMR or VM modes (Table 11-3), DS3 P-bit violations and SESF are counted, and the counts are thresholded to flag detected performance degradation of the DS3 signal incoming from the fiber.

- Enhanced DS3 Performance Monitoring (see Table 11-22 and Table 11-4)

  The Enhanced DS3 PM for the BBG19 is the same as for the BBG4/BBG4B. Refer to the DS3 Low-Speed (BBG4/4B) Enhanced DS3 Performance Monitoring section for a list of parameters.

Transmultiplexer (BBG20)

- Electrical Specification

  The DS3 Transmux interface transmits/receives a standard electrical DS3 signal as specified in *ANSI* T1.102-1993, Section 5 [44.736 Mb/s rate, DSX-3 interconnect specification, bipolar 3-zero substitution (B3ZS) encoding].

  Line buildout is provisionable as follows:

  — 734A/D: 0 to 450 ft.

  — 735A: 0 to 250 ft.

- Format Specification

  The DS3 Transmux interface provides termination for DS3 signals in both M13 and C-bit parity formats.

- Alarm Thresholding

  The following parameters are monitored at the DS3 interface from the DSX-3:

  — Loss of signal (LOS)

  — Out Of Frame (OOF)

  — AIS

  — BER (based on P-bit or C-bit parity)

The alarm level for each of the monitored parameters can be provisioned to CR, MJ, MN, or status. Coding violation failure threshold is user settable to 10^{-3} or 10^{-6} BER.

- Loopback

  — DS1 and DS3 terminal and facility loopback

- DS3 Line and Path (from DSX-3) Performance Monitoring (see Table 11-22)

  — DS3 parity errors (P-Bits, F&M Bits, C-bits) (CV-P)

  — Severely Errored Frame Seconds (SEFS)

  — Errored Seconds (ES-P)

  — Severely Errored Seconds (SES-P)

  — Unavailable Seconds (UAS-P)

  — Code Violations Line (CV-L)

  — Errored Seconds Line (ES-L)

  — Severely Errored Seconds Line (SES-L)

- DS1 Path Performance Monitoring (see Table 11-22)
  - CV-P
  - ES-P
  - SES-P
  - UAS-P
  - CV-PFE (Far-end ESF paths)
  - ES-PFE (Far-end ESF paths)
  - SES-PFE (Far-end ESF paths)
  - UAS-PFE (Far-end ESF paths)
- STS and VT Performance Monitoring (see Table 11-22)
  - All STS and VT PM is supported.

Lightguide Jumpers

The DDM-2000 Multiplexers provide Lucent's universal optical connector on all OLIUs. The universal optical connectors are receptacles on the faceplate of the OLIUs that allow a single OLIU to support either *ST*®, FC-PC, or SC connectors as needed. Both 0 dB and attenuating buildouts are supported.

The OC-1 and OC-3 lightguide interfaces use both single-mode and multimode jumpers for connecting to and from the outside plant *LGX*® panel and the DDM-2000 OC-3 Multiplexer.

When the outside plant lightguide is multimode, a single-mode or multimode jumper can be used between the *LGX* panel and the DDM-2000 OC-3 Multiplexer on the transmit (OUT) side. Multimode must be used on the receive (IN) side of all OLIUs.

When the outside plant lightguide is single-mode, a single-mode jumper must be used for the transmit side and either single-mode or multimode jumpers can be used for the receive side of all OLIUs (except the 24G-U/24H-U and 29G-U/29H-U which requires single-mode fiber on both the transmit and receive sides due to potential optical path degradations).

Regardless of the type of fiber in the outside plant, the 21D/21D-U and 22D-U OLIUs, used for intershelf OC-3/OC-12 interconnection, must be used with multimode jumpers on the transmit side.

The 24G-U/24H-U and 29G-U/29H-U OLIU must be used with single mode fiber.

Lightguide jumpers can be ordered from Lucent. See the "OC-3 Ordering — Miscellaneous Equipment and Tools" section for ordering information.

Optical Interfaces

Long Reach OC-3 Interface (21G/21G-U/21G2-U/21G3-U OLIU)

- Optical Specification

  The 21G/21G-U/21G2-U/21G3-U OLIU photonics meet or exceed SONET long reach specifications (TR 253-LR-1 MLM category). The multilongitudinal mode (MLM*) laser transmitter supplies a non-return-to-zero (NRZ) coded signal. The positive intrinsic negative field effect transistor (PINFET) receiver allows direct optical loopback without the use of an external attenuator when the TRANSMIT POWER switch is on the low setting.

  The 21G/21G-U/21G2-U/21G3-U OLIU long reach OC-3 interface supports span lengths up to 55 km, assuming 0.45 dB/km single-mode fiber (including splices) and the span engineering rules outlined in Table 11-6. Transmit and receive powers are referenced to Points S and R as shown in Figure 11-2. Table 11-5, Table 11-6, and Table 11-9 provide detailed specifications and link budget information for the 21G/21G-U/21G2-U/21G3-U OLIU.

- Alarm Thresholding

  The following parameters are monitored at the OC-3 interface:

  — LOS

  — LOF

  — LOP

  — Line AIS

  — B2 thresholding signal fail

  — B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from 10^{-5} to 10^{-9} BER.)

- PM (see Table 11-22)

  — Section severely errored frame seconds (SEFS)

  — Line parameter B2

  — Laser bias current (21G/21G-U only)

  — Transmit power (21G/21G-U only)

  — Receive power.

* A higher quality SLM laser may be used instead of a MLM laser.

Intermediate Reach OC-3 Interface (22F/22F-U/ 22F2-U OLIU)

- Optical Specification

  The 22F/22F-U/22F2-U OLIU photonics meet or exceed SONET intermediate reach specifications (TR 253-IR-1 MLM category). The multilongitudinal mode (MLM*) laser transmitter supplies an NRZ-coded signal. The PINFET receiver allows direct optical loopback without the use of an external attenuator.

  The 22F/22F-U/22F2-U OLIU intermediate reach OC-3 interface supports span lengths up to 33 km, assuming 0.45 dB/km single-mode fiber and the span engineering rules outlined in Table 11-8. Transmit and receive powers are referenced to Points S and R as shown in Figure 11-2. Table 11-7, Table 11-8, and Table 11-9 provide detailed specifications and link budget information for the 22F OLIU.

- Alarm Thresholding

  The following parameters are monitored at the OC-3 interface.

  — Loss of signal (LOS)

  — Loss of frame (LOF)

  — Loss of pointer (LOP)

  — Line AIS

  — B2 thresholding signal fail

  — B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from 10^{-5} to 10^{-9} BER.)

- Performance Monitoring (see Table 11-22)

  — Section SEFS

  — Line parameter B2.

  — STS pointer justifications (Release 11.0 and later).

* A higher quality SLM laser may be used instead of a MLM laser.

Long Reach OC-3 Interface (22G-U/22G2-U/ 22G3-U/22G4-U OLIU)

- Optical Specification

  The multilongitudinal mode (MLM*) laser transmitter supplies an NRZ-coded signal. For direct optical loopbacks, at least 7.0 dB (use 10 dB attenuator, see Table 11-20) of attenuation is needed for the 22G-U. No attenuation is needed for the 22G2-U, 22G3-U, or 22G4-U.

  The 22G-U/22G2-U OLIU long reach OC-3 interface supports span lengths up to 51 km, assuming 0.45 dB/km single-mode fiber and the span engineering rules outlined in Table 11-8. Transmit and receive powers are referenced to Points S and R as shown in Figure 11-2. Table 11-7, Table 11-8, and Table 11-9 provide detailed specifications and link budget information for the 22G-U/22G2-U OLIU.

  The 22G3-U/22G4-U OLIU is a SONET compliant long reach OC-3 interface supporting span lengths up to 55 km, assuming 0.45 dB/km single-mode fiber and the span engineering rules outlined in Table 11-8. Transmit and receive powers are referenced to Points S and R as shown in Figure 11-2. Table 11-7, Table 11-8, and Table 11-9 provide detailed specifications and link budget information for the 22G3-U/22G4-U OLIU.

- SS Byte Programmability

  The 22G4-U has accessibility to the SS bytes in the H1 byte.

- Alarm Thresholding

  The following parameters are monitored at the OC-3 interface.

  - Loss of signal (LOS)
  - Loss of frame (LOF)
  - Loss of pointer (LOP)
  - Line AIS
  - B2 thresholding signal fail
  - B2 thresholding signal degrade (B2 signal degrade thresholds are user settable in the range from 10^{-5} to 10^{-9} BER.)

- Performance Monitoring (see Table 11-22)

  - Section SEFS
  - Line parameter B2
  - STS pointer justifications (Release 11.0 and later)

* A higher quality SLM laser may be used instead of a MLM laser.

Long Reach OC-12 Interface (24G-U)

- Optical Specification

  The distributed feedback laser supplies a NRZ-coded signal. For direct optical loopbacks, at least 15 dB of optical attenuation is needed for the 24G-U.

  The 24G-U OLIU long reach OC-12 interface supports span lengths up to 51 km, assuming 0.45 dB/km single-mode fiber (including splices) and the span engineering rules outlined in Table 11-11. Transmit and receive powers are referenced to points S and R as shown in Figure 11-2. Table 11-10 and Table 11-11 provide detailed specifications and link budget information for the 24G-U OLIU. Note that the 24G-U OLIU is not specified to operate over multimode fiber.

- Alarm Thresholding

  The following parameters are monitored at the OC-12 interface.

  — Loss of signal (LOS)

  — Loss of frame (LOF)

  — Loss of pointer (LOP)

  — Line AIS

  — B2 thresholding signal fail

  — B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from 10^{-5} to 10^{-9} BER.)

- Performance Monitoring (see Table 11-22)

  — Section SEFS

  — Line parameter B2.

  — STS pointer justifications (Release 11.0 and later).

Long Reach OC-12 Interface (24H-U)

- Optical Specification

  The distributed feedback laser supplies a NRZ-coded signal. For direct optical loopbacks, at least 10 dB of optical attenuation is needed for the 24H-U.

  The 24H-U OLIU long reach OC-12 interface supports span lengths up to 96 km, assuming 0.25 dB/km single-mode fiber (including splices) and the span engineering rules outlined in Table 11-11. Transmit and receive powers are referenced to points S and R as shown in Figure 11-2. Table 11-10 and Table 11-11 provide detailed specifications and link budget information for the 24H-U OLIU. Note that the 24H-U OLIU is not specified to operate over multimode fiber.

- Alarm Thresholding

  The following parameters are monitored at the OC-12 interface.

  - Loss of signal (LOS)
  - Loss of frame (LOF)
  - Loss of pointer (LOP)
  - Line AIS
  - B2 thresholding signal fail
  - B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from 10^{-5} to 10^{-9} BER.)

- Performance Monitoring (see Table 11-22)

  - Section SEFS
  - Line parameter B2.
  - STS pointer justifications (Release 11.0 and later).

Intraoffice (IS-3) OC-3 Rate Interface (21D/21D-U and 22D-U OLIUs)

- Optical Specification

  The 21D/21D-U and 22D-U OLIUs are short-reach optical interfaces used to interconnect between the DDM-2000 OC-3 and OC-12 Multiplexers. The nominal line rate is 155.520 Mb/s. The LED transmitter supplies an NRZ-coded signal.

  Table 11-5, Table 11-6, and Table 11-9 provide detailed specifications and link budget information for the 21D/21D-U and 22D-U OLIUs.

- Alarm Thresholding

  The following parameters are monitored at the OC-3 interface.

  - Loss of signal (LOS)
  - Loss of frame (LOF)
  - Loss of pointer (LOP)
  - Line AIS
  - B2 thresholding signal fail
  - B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from 10^{-5} to 10^{-9} BER.)

- Performance Monitoring (see Table 11-22)

  - Section SEFS
  - B2 parameters.
  - STS pointer justifications (Release 11.0 and later)
    22-type only.

Long Reach OC-1 Interface (26G2-U/27G-U/27G2-U OLIU)

- Optical Specification

  The multilongitudinal mode (MLM*) laser transmitter supplies an NRZ-coded signal. For direct optical loopbacks, at least 13.8 dB (use 15.0 dB, attenuator, see Table 11-20) of attenuation is needed for the 26G2-U/27G-U/27G2-U.

  The 26G2-U/27G-U/27G2-U OLIU long reach OC-1 interface supports span lengths up to 44 km, assuming 0.45 dB/km single-mode fiber and the span engineering rules outlined in Table 11-13. Transmit and receive powers are referenced to Points S and R as shown in Figure 11-2. Table 11-12, Table 11-13, and Table 11-14 provide detailed specifications and link budget information for the 26G2-U/27G-U/27G2-U OLIU.

- Alarm Thresholding

  The following parameters are monitored at the OC-1 interface.

  — Loss of signal (LOS)

  — Loss of frame (LOF)

  — Loss of pointer (LOP)

  — Line AIS

  — B2 thresholding signal fail

  — B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from 10^{-5} to 10^{-9} BER.)

- Performance Monitoring (see Table 11-22)

  — Section SEFS

  — Line parameter B2

  — STS pointer justifications (Release 11.0 and later).

* A higher quality SLM laser may be used instead of a MLM laser.

Long Reach OC-12 Interface (29G-U)

- Optical Specification

  The distributed feedback laser supplies a NRZ-coded signal. For direct optical loopbacks, at least 10 dB of optical attenuation is needed for the 29G-U.

  The 29G-U OLIU long reach OC-12 interface supports span lengths up to 51 km, assuming 0.45 dB/km single-mode fiber (including splices) and the span engineering rules outlined in Table 11-16 Transmit and receive powers are referenced to points S and R as shown in Figure 11-2. Table 11-15 and Table 11-16 provide detailed specifications and link budget information for the 29G-U OLIU. Note that the 29G-U OLIU is not specified to operate over multimode fiber.

- Alarm Thresholding

  The following parameters are monitored at the OC-12 interface.

  — Loss of signal (LOS)

  — Loss of frame (LOF)

  — Loss of pointer (LOP)

  — Line AIS

  — B2 thresholding signal fail

  — B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from 10^{-5} to 10^{-9} BER.)

- Performance Monitoring (see Table 11-22)

  — Section SEFS

  — Line parameter B2.

  — STS pointer justifications (Release 15.0 and later).

Long Reach OC-12 Interface (29H-U)

- Optical Specification

  The distributed feedback laser supplies a NRZ-coded signal. For direct optical loopbacks, at least 10 dB of optical attenuation is needed for the 29H-U.

  The 29H-U OLIU long reach OC-12 interface supports span lengths up to 96 km, assuming 0.25 dB/km single-mode fiber (including splices) and the span engineering rules outlined in Table 11-16 Transmit and receive powers are referenced to points S and R as shown in Figure 11-2. Table 11-15 and Table 11-16 provide detailed specifications and link budget information for the 29H-U OLIU. Note that the 29H-U OLIU is not specified to operate over multimode fiber.

- Alarm Thresholding

  The following parameters are monitored at the OC-12 interface.

  - Loss of signal (LOS)
  - Loss of frame (LOF)
  - Loss of pointer (LOP)
  - Line AIS
  - B2 thresholding signal fail
  - B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from 10^{-5} to 10^{-9} BER.)

- Performance Monitoring (see Table 11-22)

  - Section SEFS
  - Line parameter B2.
  - STS pointer justifications (Release 15.0 and later).

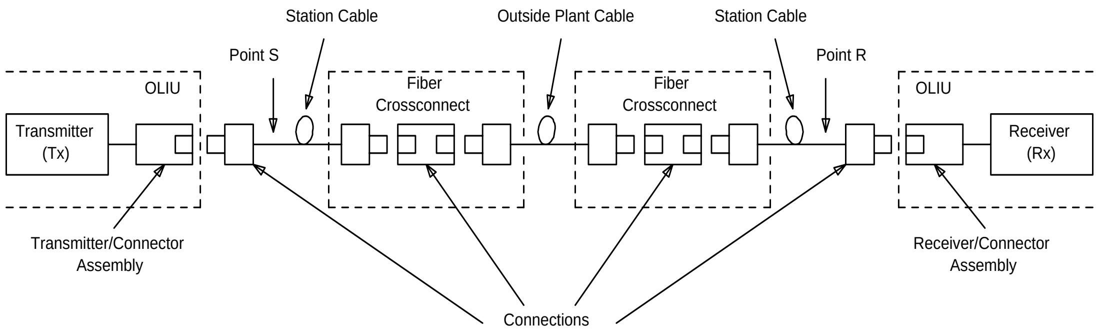

Figure 11-2. Optical System Interfaces (Points S and R)

Table 11-5 lists the 21G/21G-U/21G2-U/21G3-U and 21D/21D-U/22D-U OLIU specifications.

Table 11-5. 21G/21G-U/21G2-U/21G3-U and 21D/21D-U/22D-U OLIU Specifications

System Information:		
Terminal Equipment Identification	21G/21G-U/21G2-U/ 21G3-U OLIU	21D/21D-U/ 22D-U OLIU
Optical Line Rate (Mb/s)	155.520 Mb/s	155.520 Mb/s
Optical Line Coding	Scrambled NRZ	Scrambled NRZ
Optical Wavelength	1310 nm	1310 nm
Performance	SONET LR-1 (Long Reach)	Not applicable
Transmitter Information:		
Optical Device Temperature Controller	TEC(21G2-U/21G3-U no TEC)	No TEC
FDA Classification	Class I	Class I
Optical Source	InGaAsP Laser, MLM* Structure	LED
Faceplate Optical Connector	Lucent *ST*® C3000-A-2 (21G) UOC buildout assembly† (21G-U/21G2-U/21G3-U‡) Single Mode	Lucent *ST* C2000-A-2(21D) UOC buildout assembly† (21D-U, 22D-U) Multimode
Receiver Information:		
Optical Device Temperature Controller	None	None
Optical Detector	InGaAsP PIN	InGaAsP PIN
Faceplate Optical Connector	Lucent *ST* C2000-A-2 (21G) UOC buildout assembly† (21G-U/21G2-U/21G3-U‡) Multimode	Lucent *ST* C2000-A-2 (21D) UOC buildout assembly† (21D-U, 22D-U) Multimode

* A higher quality SLM laser may be used instead of the MLM.

† The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either *ST*, SC, or FC-type connectors.

‡ The 21G3-U ships with two (2) 0 dB SC line buildouts installed and includes two (2) *ST* 0 dB buildouts shipped loose with the unit.

Table 11-6. 21G/21G-U/21G2-U/21G3-U and *21D/21D-U/22D-U OLIU Link Budgets

Parameter (Note 1)	21G2-U/21G3-U††† (Note 3)	21G/21G-U (Note 2)		21D/21D-U/22D-U
		Tx High	Tx Low	
Minimum Wavelength (l_{Tmin})	1280 nm	1280 nm	1280 nm	1270/1260* nm
Maximum Wavelength (λ_{Tmax})	1335 nm	1335 nm	1335 nm	1380 nm
Spectral Width ($\delta\lambda_{rms}$)	4.0 nm *** 1.0 nm (21G3-U)	4.0nm	4.0nm	170 nm ¶¶
Maximum Transmitter Power (P_{Tmax})	0.0 dBm	–2.5 dBm	–7.5 dBm	–14.0 dBm
Minimum Transmitter Power (P_{Tmin})	–5.0 dBm	–5.0 dBm	–11.4 dBm	–18.8/–21.8 dBm
Maximum Received Power (P_{Rmax})	0.0 dBm	–7.0 dBm	–7.0 dBm	–14.0 dBm
Minimum Received Power (P_{Rmin})	–34.0 dBm	–34.0 dBm	–34.0 dBm	–33.8/–31.8* dBm
Minimum System Gain (S-R)‡	29.0 dB	29.0 dB	22.6 dB	15/10.0* dB
Optical Path Penalty (P_O)§	1.0 dB	1.0 dB	1.0 dB	1.6 dB
Connector Loss¶	1.5 dB	1.5 dB	1.5 dB	1.5 dB
Unallocated Margin**	1.5 dB	1.5 dB	1.5 dB	2.0 dB
Minimum Loss Budget	0.0 dBm	4.5 dB††	0.0 dB	0.0 dB
Maximum Loss Budget‡‡	**25.0 dB**	**25.0 dB**	**18.6 dB**	**9.9/4.9* dB**
Maximum Span Length§§	55 km	55 km	41 km	(Note 4)

Notes:

1. All terminology is consistent with TR-253, Issue 2. All specifications for 21G/21G-U/21G2-U/21G3-U OLIU meets or exceeds long reach (LR) values described in TR-253, Iss. 2.
2. The High/Low transmitted power switch on the 21G/21G-U OLIU circuit pack allows for loopbacks or small outside plant (OSP) budgets without external attenuators.
3. The 21G2-U/21G3-U does not have a High/Low transmitter power switch. When transmitting from a 21G2-U/21G3-U to a 21G-U, 22F, 22D-U or 22G-U OLIU, an external attenuator may be required. An attenuator is not required when transmitting to a 22F-U/22F2-U or 22G2-U/22G3-U/22G4-U OLIU.
4. Multimode only (see Table 11-9).

* When two numbers are given, the number before the slash is the specification for operating under controlled environmental conditions. The number following the slash is the specification for uncontrolled environmental conditions. If only one number is given, it applies to both controlled and uncontrolled environmental conditions.

† Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

‡ The minimum system gain for the DDM-2000 already takes into account aging, temperature, and manufacturing tolerances as these figures are built into the minimum transmitter power. The DDM-2000 system gain can, thus, not be directly compared with the DDM-1000 system gain because the DDM-1000 system gain does not include all of these effects. A similar penalty, called eye margin, is subtracted from the DDM-1000 loss budget after the value of system gain is determined.

† Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

§ Optical path penalty includes effects of dispersion, reflection, and jitter that occur on the optical path.

¶ One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.

** Unallocated margin, or safety margin, is typically specified from 0 dB to 3 dB.

†† If the loss budget is less than 6.0 dB, use low power. Includes a 1.5 dB safety margin.

‡‡ Budget available for both station and transmission cable and splices.

§§ Attenuation and dispersion can be the limiting factors in span length. For OC-3 single-mode fiber systems, dispersion is not a factor and all applications are attenuation limited. For OC-12 systems, the maximum distance could be either attenuation limited or dispersion limited. The limits must be calculated based on both factors and the lesser of the two defines the actual maximum span length. A rough rule of thumb for attenuation-limited systems is 0.45 dB/km. This estimate includes typical cable loss (0.4 dB/km) and splice loss (0.2 dB per splice, 11 total splices) associated with single-mode fiber.

Maximum span length can be calculated more precisely based on particular fiber and splice characteristics and local engineering rules.

¶¶ Full width at half maximum (FWHM) spectral width.

*** 1.0 nm for a SLM laser.

††† The 21G3-U OLIU will replace the 21G, 21G-U, and 21G2-U OLIUs.

Table 11-7 lists the 22F/22F-U/22F2-U and 22G-U/22G2-U/22G3-U/22G4-U OLIU specifications.

Table 11-7. 22F/22F-U/22F2-U and 22G-U/22G2-U/22G3-U/22G4-U OLIU Specifications

System Information:			
Terminal Equipment Identification	22F/22F-U/22F2-U OLIU	22G-U/22G2-U OLIU	22G3-U/22G4-U OLIU
Optical Line Rate (Mb/s)	155.520 Mb/s	155.520 Mb/s	155.520 Mb/s
Optical Line Coding	Scrambled NRZ	Scrambled NRZ	Scrambled NRZ
Optical Wavelength	1310 nm	1310 nm	1310 nm
Performance	SONET IR-1 MLM (Intermediate Reach)	Not applicable	SONET LR-1 (Long Reach)
Transmitter Information:			
Optical Device Temperature Controller	No TEC	No TEC	No TEC
FDA Classification	Class I	Class I	Class I
Optical Source	InGaAsP Laser, MLM* Structure	InGaAsP Laser, MLM* Structure	InGaAsP Laser, MLM* Structure
Faceplate Optical Connector	Lucent *ST* (Integral to transmitter) Single Mode	UOC buildout assembly† Single Mode	UOC buildout assembly† Single Mode
Receiver Information:			
Optical Device Temperature Controller	None	None	None
Optical Detector	InGaAsP PIN	InGaAsP PIN (22G-U)	InGaAs PIN
Faceplate Optical Connector	Lucent *ST* C2000-A-2 (22F)22F-U/22F2-U	InGaAs PIN (22G2-U) UOC buildout assembly† Multimode	UOC buildout assembly† Multimode

* A higher quality SLM laser may be used instead of the MLM. The 22G4-U OLIU uses the SLM laser.

† The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either *ST*, SC, or FC-type connectors.

Table 11-8. 22F/22F-U/22F2-U, 22G-U, 22G2-U, 22G3-U, and 22G4-U OLIU Link Budgets

Parameter (Note)	22F/22F-U/ 22F2-U	22G-U	22G2-U	22G3-U	22G4-U*
Minimum Wavelength (λ_{Tmin})	1260 nm	1272 nm	1272 nm	1280 nm	1280 nm
Maximum Wavelength (λ_{Tmax})	1360 nm	1350 nm	1350 nm	1335 nm	1335 nm
Spectral Width ($\delta\lambda_{rms}$)	7.7 nm	3.0 nm	3.0 nm	4.0 nm	1.0 nm ¶¶
Maximum Transmitter Power† (P_{Tmax})	–8.0 dBm	0.0 dBm	0.0 dBm	0.0 dBm	0.0 dBm
Minimum Transmitter Power (P_{Tmin})	–15.0 dBm	–7.0 dBm	–7.0 dBm	–5.0 dBm	–5.0 dBm
Maximum Received Power (P_{Rmax})	–7.0 dBm	–7.0 dBm	0.0 dBm	0.0 dBm	0.0 dBm
Minimum Received Power (P_{Rmin})	–34.0 dBm	–34.0 dBm	–34.0 dBm	–34.0 dBm	–34.0 dBm
Minimum System Gain (S-R)‡	19.0 dB	27.0 dB	27.0 dB	29.0 dB	29.0 dB
Optical Path Penalty (P_O)§	1.0 dB	1.0 dB	1.0 dB	1.0 dB	1.0 dB
Connector Loss¶	1.5 dB	1.5 dB	1.5 dB	1.5 dB	1.5 dB
Unallocated Margin**	1.5 dB	1.5 dB	1.5 dB	1.5 dB	1.5 dB
Minimum Loss Budget	0.0 dB	7.0 dB	0.0 dB	0.0 dB	0.0 dB
Maximum Loss Budget‡‡	**15.0 dB**	**23.0 dB**	**23.0 dB**	**25.0 dB**	**25.0 dB**
Maximum Span Length§§	33 km	51 km	51 km	55 km	55 km

Note:

1. All terminology is consistent with TR-253, Iss. 2. All specifications for the 22F OLIU meet or exceeds intermediate reach (IR) values described in TR-253, Iss. 2.

* The 22G4-U OLIU is fully compliant with SONET long reach applications. It is fully compatible with the 22F-type, 22G-U, 22G2-U, and 22G3-U OLIUs and will replace them.

† Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

‡ The minimum system gain for the DDM-2000 already takes into account aging, temperature, and manufacturing tolerances as these figures are built into the minimum transmitter power. The DDM-2000 system gain can, thus, not be directly compared with the DDM-1000 system gain because the DDM-1000 system gain does not include all of these effects. A similar penalty, called eye margin, is subtracted from the DDM-1000 loss budget after the value of system gain is determined.

§ Optical path penalty includes effects of dispersion, reflection and jitter that occur on the optical path.

¶ One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.

** Unallocated margin, or safety margin, is typically specified from 0 dB to 3 dB.

‡‡ Budget available for both station and transmission cable and splices.

§§ Attenuation and dispersion can be the limiting factors in span length. For OC-3 single-mode fiber systems, dispersion is not a factor and all applications are attenuation limited. For OC-12 systems, the maximum distance could be either attenuation limited or dispersion limited. The limits must be calculated based on both factors and the lesser of the two defines the actual maximum span length. A rough rule of thumb for attenuation-limited systems is 0.45 dB/km. This estimate includes typical cable loss (0.4 dB/km) and splice loss (0.2 dB per splice, 11 total splices) associated with single-mode fiber.

Maximum span length can be calculated more precisely based on particular fiber and splice characteristics and local engineering rules.

¶¶ 1.0 nm for a SLM laser.

Table 11-9. OC-3 OLIU Link Budget - Multimode Operation

Fiber Bandwidth	Maximum Span Length (km) 21G/21G-U/ 21G2-U/21G3-U (Note 1)	22F/22F-U/ 22F2-U (Note 2)	21D/21D-U/ 22D-U (Note 3)	22G/22G-U/ 22G2-U/22G3-U/ 22G4-U (Note 4)
1000 MHz-km	6.5	6.5	3.6/3.4	6.5
800 MHz-km	5.1	5.1	3.4/3.3	5.1
500 MHz-km	3.1	3.1	2.7	3.1
300 MHz-km	1.8	1.8	1.9	1.8

Notes:

1. Maximum 21G/21G-U/21G2-U/21G3-U MM Link Budget (dB) for multimode operation is 22.0 dB for high power and 15.6 for low power (21G/21G-U only).
2. Maximum 22F-type MM Link Budget (dB) for multimode operation is 12.0 dB.
3. When two numbers are given, the number before the slash is the specification for operating under controlled environmental conditions. The number following the slash is the specification for uncontrolled environmental conditions. If only one number is given, it applies to both controlled and uncontrolled environmental conditions.
4. The 22G4-U will replace the 22F-type and the 22G/22G-U/22G2-U and 22G3-U OLIUs.

The system is dispersion limited for all the fiber bandwidths listed in Table 11-9.

Multimode fiber operation on the DDM-2000 OC-3 Multiplexer requires a minimum exit bandwidth of 120 MHz to ensure that dispersion loss is kept below acceptable levels. If the fiber is already installed and the exit bandwidth is measured to be 120 MHz or greater, then the maximum link budget values (see Notes 1 and 2) can be used to determine if the loss budget is sufficient for that fiber.

If planning a new fiber installation, the values at the end of the table, given for a number of commercially available fiber bandwidth-distance products, can be used. Fiber distances are calculated using the 120 MHz exit bandwidth limit; however, actual exit bandwidths may be higher for these distances due to the existence of splices. This may permit longer span lengths to be achieved, for the given fiber bandwidths, than those specified in the table. In this case, however, the span length can only be increased to the point where the system is loss limited as specified by the maximum multimode link budget given in the table (1 dB/km cable is assumed).

Table 11-10. 24G-U/24H-U OLIU Specifications

System Information:		
Terminal Equipment Identification	24G-U OLIU	24H-U OLIU
Optical Line Rate (Mb/s)	622.080 Mb/s	622.080 Mb/s
Optical Line Coding	Scrambled NRZ	Scrambled NRZ
Optical Wavelength (nm)	1310 nm	1550 nm
Performance	SONET LR-1 DFB (Long Reach)	SONET LR-1 DFB (Long Reach)
Transmitter Information:		
Optical Device Temperature Controller	None	None
FDA Classification	Class I	Class I
Optical Source	InGaAsP Laser, SLM Structure	InGaAsP Laser, SLM Structure
Faceplate Optical Connector	UOC Buildout Assembly (single-mode) *	UOC Buildout Assembly (single-mode) *
Receiver Information:		
Optical Device Temperature Controller	None	None
Optical Detector	InGaAs PIN	InGaAs PIN
Faceplate Optical Connector	UOC Buildout Assembly (multi-mode) *	UOC Buildout Assembly (multi-mode) *

* The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either *ST*, SC, or FC-type connectors.

Table 11-11. 24G-U/24H-U OLIU Link Budgets (Notes)

Parameter	24G-U	24G-U (S1:2)	24H-U
Minimum Wavelength (λ_{Tmin})	1280 nm	1280 nm	1530 nm
Maximum Wavelength (λ_{Tmax})	1335 nm	1335 nm	1570 nm
Spectral Width ($\delta\lambda_{20}$)	1.0 nm	1.0 nm	1.0 nm
Maximum Transmitter Power ∗(P_{Tmax})	+1.9 dBm	+1.9 dBm	+2.0 dBm
Minimum Transmitter Power (P_{Tmin})	–3.0 dBm	–2.5 dBm	–2.5 dBm
Maximum Received Power (P_{Rmax})	–8.0 dBm	–8.0 dBm	–8.0 dBm
Minimum Received Power (P_{Rmin})	–30.0 dBm	–30.5 dBm	–31.0 dBm
Minimum System Gain (S-R) †	27.0 dB	28.0 dB	28.5 dB
Optical Path Penalty (P_O) ‡	1.0 dB	1.0 dB	1.0 dB
Connector Loss §	1.5 dB	1.5 dB	1.5 dB
Unallocated Margin ¶	1.5 dB	1.5 dB	2.0 dB
Minimum Loss Budget ∗∗	10.0 dB	10.0 dB	10.0 dB
Maximum Loss Budget ††	**23.0 dB**	**24.0 dB**	**24.0 dB**
Maximum Span Length ‡‡	51 km	51 km	96 km

Notes:

1. All terminology is consistent with TR-253, Iss. 2. All values are worst-case end of life.
2. All specifications for the 24G-U/24H-U meet or exceed long reach (LR) values described in TR-253, Iss. 2.

∗ Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

† The minimum system gain for the DDM-2000 already takes into account aging, temperature, and manufacturing tolerances as these figures are built into the minimum transmitter power. The DDM-2000 system gain can, thus, not be directly compared with the DDM-1000 system gain because the DDM-1000 system gain does not include all of these effects. A similar penalty, called eye margin, is subtracted from the DDM-1000 loss budget after the value of system gain is determined.

‡ Optical path penalty includes effects of dispersion, reflection and jitter that occur on the optical path. The 24G-U has 4.0 dB of total margin. Optical path penalty is normally 1.0 dB. The 24H-U has 4.5 dB of total margin. Optical path penalty is normally 1.0 dB, which implies 1800 psec/nm total dispersion. Typical nondispersion fiber has 10 psec/nm km dispersion in the 1550 nm wavelength range.

§ One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.

¶ Unallocated margin, or safety margin, is typically specified from 0 dB to 3 dB.

** The 24G-U/24H-U requires an external lightguide buildout as part of the connector assembly for loopbacks and for loss budgets less than 10 dB.

†† Budget available for both station and transmission cable and splices.

‡‡ Attenuation can be the limiting factors in span length. A rough rule of thumb for attenuation-limited systems operating in the 1310 nm wavelength range is 0.45 dB/km. This estimate includes typical cable loss (0.4 dB/km) and splice loss (0.2 dB per splice, 11 total splices) associated with single-mode fiber in the 1310 nm range.

For the 24G-U, the maximum distance is not dispersion limited because single longitudinal mode laser is used. Given the attenuation assumption, the maximum span length for the 24G-U is 51 km.

Attenuation can be the limiting factors in span length. A rough rule of thumb for attenuation-limited systems operating in the 1550 nm wavelength range is 0.25 dB/km, including cable and splice loss.

For the 24H-U, the maximum distance is not dispersion limited because single longitudinal mode laser is used. Given the attenuation assumption, the maximum span length for the 24H-U is 96 km.

Maximum span length can be calculated more precisely based on particular fiber and splice characteristics and local engineering rules.

Table 11-12, Table 11-13, and Table 11-14 lists the 26G2-U/27G-U/27G2-U OLIU specifications and link budgets.

Table 11-12. 26G2-U/27G-U/27G2-U OLIU Specifications

System Information:	
Terminal Equipment Identification	26G2-U/27G-U/27G2-U OLIU
Optical Line Rate (Mb/s)	51.84 Mb/s
Optical Line Coding	Scrambled NRZ
Optical Wavelength	1310 nm
Performance	Not applicable
Transmitter Information:	
Optical Device Temperature Controller	No TEC
FDA Classification	Class I
Optical Source	InGaAsP Laser, MLM* Structure
Faceplate Optical Connector	UOC buildout assemble† Single Mode
Receiver Information:	
Optical Device Temperature Controller	None
Optical Detector	InGaAsP PIN
Faceplate Optical Connector	UOC buildout assemble† Multimode

* A higher quality SLM laser may be used instead of the MLM laser.

† The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either *ST*, SC, or FC-type connectors.

Table 11-13. 26G2-U/27G-U/27G2-U OLIU Link Budgets (Note)

Parameter	Value
Minimum Wavelength (λ_{Tmin})	1272 nm
Maximum Wavelength (λ_{Tmax})	1350 nm
Spectral Width ($\delta\lambda_{rms}$)	3.0 nm
Maximum Transmitter Power (P_{Tmax}) ∗	–0.0 dBm
Minimum Transmitter Power (P_{Tmin}) ∗	–7.0 dBm
Maximum Received Power (P_{Rmax})	–13.8 dBm
Minimum Input Power (P_{Rmin})	–30.8 dBm
Minimum System Gain (S-R)‡	23.8 dB
Optical Path Penalty (P_O) †	1.0 dB
Connector Loss ‡	1.5 dB
Unallocated Margin	1.5 dB
Minimum Loss Budget	13.8 dB
Maximum Loss Budget	**19.8 dB**
Maximum Span Length§	44 km

Note:

1. All values are for both controlled and uncontrolled environmental conditions.

∗ Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

† Optical path penalty includes effects of dispersion, reflection and jitter that occur on the optical path.

‡ One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.

§ The 26G2-U/27G-U/27G2-U OLIUs are dispersion limited at 44 km, due to the wider wavelength range. Assuming fiber with zero dispersion wavelength between 1300 and 1320 nm, the worst case dispersion over the transmitter wavelength range of 1272 to 1350 nm is 4.88 psec/nm km. This implies a 44 km span would have a total dispersion of about 215 psec/nm.

Table 11-14. 26G2-U/27G-U/27G2-U OLIU Link Budgets — Multimode Operation (Notes)

Fiber Bandwidth	Maximum Span Length (km)
1000 MHz-km	19.8
800 MHz-km	19.8
500 MHz-km	19.8
300 MHz-km	13.6

Notes:

1. The maximum Link Budget loss is 19.8 dB
2. Multimode fiber operation requires a minimum exit bandwidth of 44 MHz to ensure that dispersion loss is kept below acceptable levels. If the fiber is already installed and the exit bandwidth is measured to be 44 MHz or greater, then the maximum link budget values can be used to determine if the loss budget is sufficient for that fiber.
3. If planning a new fiber installation, the values given in the table (given for a number of commercially available fiber bandwidth-distance products) can be used. Fiber distances are calculated using the 44 MHz exit bandwidth limit; however, actual exit bandwidths may be higher for these distances due to the existence of splices. This may permit longer span lengths to be achieved for the given fiber bandwidths than those specified in the table. In this case, however, the span length can only be increased to the point where the system is loss limited as specified by the maximum multimode link budget given in the table (1 dB/km cable is assumed).

Table 11-15. 29G-U/29H-U OLIU Specifications

System Information:		
Terminal Equipment Identification	29G-U OLIU	29H-U OLIU
Optical Line Rate (Mb/s)	622.080 Mb/s	622.080 Mb/s
Optical Line Coding	Scrambled NRZ	Scrambled NRZ
Optical Wavelength (nm)	1310 nm	1550 nm
Performance	SONET LR-1 DFB (Long Reach)	SONET LR-1 DFB (Long Reach)
Transmitter Information:		
Optical Device Temperature Controller	None	None
FDA Classification	Class I	Class I
Optical Source	InGaAsP Laser, SLM Structure	InGaAsP Laser, SLM Structure
Faceplate Optical Connector	UOC Buildout Assembly (single-mode) *	UOC Buildout Assembly (single-mode) *
Receiver Information:		
Optical Device Temperature Controller	None	None
Optical Detector	InGaAs PIN	InGaAs PIN
Faceplate Optical Connector	UOC Buildout Assembly (multi-mode) *	UOC Buildout Assembly (multi-mode) *

***** The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either *ST*, SC, or FC-type connectors.

Table 11-16. 29G-U/29H-U OLIU Link Budgets (Notes)

Parameter	29G-U	29H-U
Minimum Wavelength (λ_{Tmin})	1280 nm	1530 nm
Maximum Wavelength (λ_{Tmax})	1335 nm	1570 nm
Spectral Width ($\delta\lambda_{20}$)	1.0 nm	1.0 nm
Maximum Transmitter Power ∗(P_{Tmax})	+1.9 dBm	+2.0 dBm
Minimum Transmitter Power (P_{Tmin})	–2.5 dBm	–2.5 dBm
Maximum Received Power (P_{Rmax})	–8.0 dBm	–8.0 dBm
Minimum Received Power (P_{Rmin})	–30.5 dBm	–31.0 dBm
Minimum System Gain (S-R) †	28.0 dB	28.5 dB
Optical Path Penalty (P_O) ‡	1.0 dB	1.0 dB
Connector Loss §	1.5 dB	1.5 dB
Unallocated Margin ¶	1.5 dB	2.0 dB
Minimum Loss Budget ∗∗	8.0 dB	10.0 dB
Maximum Loss Budget ††	**24.0 dB**	**24.0 dB**
Maximum Span Length ‡‡	51 km	96 km

Notes:

1. All terminology is consistent with TR-253, Iss. 2. All values are worst-case end of life.
2. All specifications for the 29G-U/29H-U meet or exceed long reach (LR) values described in TR-253, Iss. 2.

∗ Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

† The minimum system gain for the DDM-2000 already takes into account aging, temperature, and manufacturing tolerances as these figures are built into the minimum transmitter power. The DDM-2000 system gain can, thus, not be directly compared with the DDM-1000 system gain because the DDM-1000 system gain does not include all of these effects. A similar penalty, called eye margin, is subtracted from the DDM-1000 loss budget after the value of system gain is determined.

‡ Optical path penalty includes effects of dispersion, reflection and jitter that occur on the optical path. The 29G-U has 4.0 dB of total margin. Optical path penalty is normally 1.0 dB. The 29H-U has 4.5 dB of total margin. Optical path penalty is normally 1.0 dB, which implies 1800 psec/nm total dispersion. Typical nondispersion fiber has 10 psec/nm km dispersion in the 1550 nm wavelength range.

§ One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.

¶ Unallocated margin, or safety margin, is typically specified from 0 dB to 3 dB.

** The 29G-U/29H-U requires an external lightguide buildout as part of the connector assembly for loopbacks and for loss budgets less than 10 dB.

†† Budget available for both station and transmission cable and splices.

‡‡ Attenuation can be the limiting factors in span length. A rough rule of thumb for attenuation-limited systems operating in the 1310 nm wavelength range is 0.45 dB/km. This estimate includes typical cable loss (0.4 dB/km) and splice loss (0.2 dB per splice, 11 total splices) associated with single-mode fiber in the 1310 nm range.

For the 29G-U, the maximum distance is not dispersion limited because single longitudinal mode laser is used. Given the attenuation assumption, the maximum span length for the 29G-U is 51 km.

Attenuation can be the limiting factors in span length. A rough rule of thumb for attenuation-limited systems operating in the 1550 nm wavelength range is 0.25 dB/km, including cable and splice loss.

For the 29H-U, the maximum distance is not dispersion limited because single longitudinal mode laser is used. Given the attenuation assumption, the maximum span length for the 29H-U is 96 km.

Maximum span length can be calculated more precisely based on particular fiber and splice characteristics and local engineering rules.

OC-3 Optical Interface Mixing

Mixing different OC-3 rate OLIUs at opposite ends of an optical link is often necessary for technical reasons or for convenience. The following information will aid in planning and engineering optical links having different types of OC-3 rate OLIUs at each end of the fiber. Table 11-17 details the minimum link budget necessary for each pairing of OC-3 rate OLIUs.

To use Table 11-17, locate the number at the intersection of the transmitter/receiver pair of interest. This number is the minimum attenuation necessary for proper operation of that transmitter/receiver pair. The link must have at least this much attenuation either from fiber loss, splice loss, connector loss, external attenuators, or a combination of these, or the receiver will be overdriven and the link will not operate properly.

Table 11-17. OC-3 Rate OLIU Mixes - Minimum Link Budgets (dB)

	Receiver						
Transmitter	**21G/21G-U**	**22F**	**22G-U***	**22G2-U 22G3-U 22G4-U**	**21D/21D-U/ 22D-U (Ctrld/ Unctrld Env.)**	**21G2-U 21G3-U**	**22F-U/ 22F2-U**
21G/21G-U (high power)	4.5	4.5	4.5	0.0	11.5	0.0	0.0
21G/21G-U (low power)	0.0	0.0	0.0	0.0	6.5	0.0	0.0
21G-U (S1:2)	7.0	7.0	7.0	0.0	14.0	0.0	0.0
22F	0.0	0.0	0.0	0.0	6.0	0.0	0.0
22F-U/22F2-U	0.0	0.0	0.0	0.0	6.0	0.0	0.0
22G-U*	7.0	7.0	7.0	0.0	14.0	0.0	0.0
22G2-U	7.0	7.0	7.0	0.0	14.0	0.0	0.0
21D/21D-U/ 22D-U (ctrld./ unctrld. env.)	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0

* The LAA10 FT-2000 OC-3 Optical Interface has the same optical loss budget as the 22G-U and therefore should follow the same optical mixing rules.

The minimum link budget is not always symmetrical. A transmitter/receiver pair may have one minimum link budget in one direction and another in the opposite direction. For example, a 21G/21G-U (low power) OLIU transmitting to a 21D/21D-U (controlled environment) OLIU has a minimum link budget of 6.5 dB. In the opposite direction, though, a 21D/21D-U (controlled environment) OLIU transmitting to a 21G/21G-U (low power) OLIU has a minimum link budget of 0.0 dB. Be careful of this asymmetry when planning and engineering a link having mixed OLIUs.

When using universal optical buildout attenuators for OLIUs equipped with Universal Optical Connectors (for example, 22G-U and 22D-U), the buildout must have the same type fiber on both sides, that is, single-mode to single-mode or multimode to multimode. The buildout must also match the mode of the fiber. Therefore, when a single-mode jumper is used, the buildout would be on the transmit side (OUT) of the OLIU and when a multimode jumper is used, the buildout would be on the receive side (IN) of the OLIU. When using in-line attenuators for non-U OLIUs, place the attenuator in the bay frame PANDUIT. Make sure that the mode type of the attenuator matches the mode of the fiber to ensure proper attenuation.

Table 11-18 details the maximum link budgets for each pairing of OC-3 rate OLIUs when operating on single-mode (SM) fiber. These numbers give the maximum attenuation acceptable for proper operation of each transmitter/receiver pair. The link must have no more than this much attenuation either from fiber loss, splice loss, connector loss, external attenuators or a combination of these or the link will not operate properly. The maximum link budgets for SM fiber were calculated using the following margins:

- Optical Path Penalty (dB) 1.0
- Connector Loss (dB) 1.5

Table 11-18. OC-3 Rate OLIU Mixes - Maximum Link Budgets for SM Fiber (dB)

	Receiver					
Transmitter	**21G/ 21G-U**	**22F**	**22G-U*/ 22G2-U**	**21D/21D-U/ 22D-U (Ctrld. Env.)**	**21D/21D-U/ 22D-U (Unctrld. Env.)**	**21G2-U 21G3-U 22G3-U 22G4-U**
21G/21G-U/21G2-U (high power)	25.0	25.0	25.0	24.8	22.8	25.0
21G/21G-U (low power)	18.6	18.6	18.6	18.4	16.4	18.6
22F	15.0	15.0	15.0	14.8	12.8	15.0
22G-U*/22G2-U	23.0	23.0	23.0	22.8	20.8	23.0
21D/21D-U/22D-U (ctrld. env.)	n/a	n/a	n/a	n/a	n/a	n/a
21D/21D-U/22D-U (unctrld. env.)	n/a	n/a	n/a	n/a	n/a	n/a
21G2-U/21G3-U 22G3-U/22G4-U	25.0	25.0	25.0	24.8	22.8	25.0

* The LAA10 FT-2000 OC-3 Optical Interface has the same optical loss budget as the 22G-U and therefore should follow the same optical mixing rules.

The maximum link budget is not always symmetrical. A transmitter/receiver pair may have one maximum link budget in one direction and another in the opposite direction. For example, a 21G/21G-U (low power) OLIU transmitting to a 22F OLIU has a maximum SM link budget of 18.6 dB. In the opposite direction, though, a 22F OLIU transmitting to a 21G/21G-U (low power) OLIU has a maximum SM link budget of 15.0 dB. Be careful of this asymmetry when planning and engineering a link having mixed OLIUs. Note also that 21D/21D-U and 22D-U OLIUs will not operate when transmitting into single-mode fiber.

Table 11-19 details the maximum link budgets for each pairing of OC-3 rate OLIUs when operating on multimode (MM) fiber. These numbers give the maximum attenuation acceptable for proper operation of each transmitter/receiver pair. The link must have no more than this much attenuation either from fiber loss, splice loss, connector loss, external attenuators or a combination of these or the link will not operate properly. The maximum link budgets for MM fiber were calculated using the following margins. The first column of margins applies to any link where there is at least one OC-3 OLIU (21G/21G-U, 22F or 22G-U/22G2-U). The second column of margins applies to links having two IS-3 (21D/21D-U or 22D-U) OLIUs.

	At Least One OC-3 OLIU	IS-3 OLIUs Only
MM Optical Path Penalty (dB)	4.0	1.6
Connector Loss (dB)	1.5	1.5
Unallocated Margin (dB)	1.5	2.0

The maximum link budget is not always symmetrical. A transmitter/receiver pair may have one maximum link budget in one direction and another in the opposite direction. For example, a 21G/21G-U (low power) transmitting to a 22F has a maximum MM link budget of 15.6 dB. In the opposite direction, though, a 22F transmitting to a 21G/21G-U (low power) has a maximum SM link budget of 12.0 dB. Be careful of this asymmetry when planning and engineering a link having mixed OLIUs.

Table 11-19. OC-3 Rate OLIU Mixes—Maximum Link Budgets for MM Fiber (dB)

Transmitter	Receiver				
	21G/21G-U 21G2-U 21G3-U	**22F**	**22G-U∗/ 22G2-U 22G3-U 22G4-U**	**21D/21D-U/ 22D-U (Ctrld. Env.)**	**21D/21D-U/ 22D-U (Unctrld. Env.)**
21G/21G-U (high power) 21G2-U/21G3-U 22G4-U	22.0	22.0	22.0	21.8	19.8
21G/21G-U (low power)	15.6	15.6	15.6	15.4	13.4
22F	12.0	12.0	12.0	11.8	9.8
22G-U∗/22G2-U	20.0	20.0	20.0	19.8	17.8
21D/21D-U/22D-U (ctrld. env.)	8.2	8.2	8.2	9.9	7.9
21D/21D-U/22D-U (unctrld. env.)	5.2	5.2	5.2	6.9	4.9

* The LAA10 FT-2000 OC-3 Optical Interface has the same optical loss budget as the 22G-U and, therefore, should follow the same optical mixing rules.

Universal Optical Connector Attenuators

The DDM-2000 OC-3 and OC-12 Multiplexers provide Lucent's universal optical connector on all OLIUs. This connector is a two-part connector consisting of a faceplate-mounted block and an optical buildout. The faceplate block optionally supports an *ST*, SC, or FC-type optical buildout.

A 0 dB SC-type connector is shipped installed on each OLIU. A 0 dB *ST*-type connector is shipped loose in the packaging with each OLIU. Optional SC, *ST*, or FC 0 dB or attenuated buildouts can be ordered separately as listed in Table 11-20. Table 11-20 lists single-mode (SM) and multimode (MM) attenuated buildouts.

Table 11-20. Universal Buildout Attenuators

Description	Connection	Loss (dB)	Comcode
A3010A *ST*® 0 dB buildout *	SM-SM	0	106312523
A3010B *ST* 5 dB buildout *	SM-SM	5	106312556
A3010C *ST* 10 dB buildout *	SM-SM	10	106312572
A3010D *ST* 15 dB buildout *	SM-SM	15	106312598
A3010E *ST* 20 dB buildout *	SM-SM	20	106312630
A3060 SC 0 dB buildout	SM-SM & MM-MM	0	106708951
A3060B1 SC 5 dB buildout	SM-SM	5	107406142
A3060D1 SC 10 dB buildout	SM-SM	10	107406159
A3060F1 SC 15 dB buildout	SM-SM	15	107406167
A3070 *ST*® 0 dB buildout	SM-SM & MM-MM	0	106795354
A3070B1 *ST* 5 dB buildout	SM-SM	5	107406183
A3070D1 *ST* 10 dB buildout	SM-SM	10	107406191
A3070F1 *ST* 15 dB buildout	SM-SM	15	107406209
A3080 FC 0 dB buildout	SM-SM & MM-MM	0	106795404
A3080B1 FC 5 dB buildout	SM-SM	5	107406225
A3080D1 FC 10 dB buildout	SM-SM	10	107406233
A3080F1 FC 15 dB buildout	SM-SM	15	107406241
A2060B SC 5 dB buildout	MM-MM	5	106795271
A2060D SC 10 dB buildout	MM-MM	10	106795289
A2060F SC 15 dB buildout	MM-MM	15	106795297
A2070B *ST* 5 dB buildout	MM-MM	5	106795313
A2070D *ST* 10 dB buildout	MM-MM	10	106795321
A2070F *ST* 15 dB buildout	MM-MM	15	106795339

* 23G and 23H only.

SONET Overhead Bytes

The DDM-2000 OC-3 Multiplexer currently uses the K2 and S1 byte in the SONET format for synchronization signaling. The reserved V4 byte in the VT1.5 superframe is used for internal fault detection in a DDM-2000 OC-3 Multiplexer shelf. This internal usage of the V4 byte may cause the value of the transmitted V4 byte to vary.

The DDM-2000 OC-3 Multiplexer does not depend on, and always ignores, the value of the V4 byte received from another DDM-2000 or other shelf with an OC-3 interface.

Performance

Wander/Jitter

- The OC-3 interface accommodates at least 10 microseconds of wander per 24-hour period without buffer overflow or depletion.
- For SONET optical interfaces, the maximum time interval error (MTIE) does not exceed 60 nanoseconds phase variation when timed with a wander-free reference
- Jitter transfer, tolerance, and generation requirements are met as specified in TR-253 and TR-499
- The SONET interfaces meet the T1.101 OC-N output short-term stability mask.

Signal Performance

The following specifications apply given the standard networks defined in TR-499, Issue 5.

- For systems interfacing at the DS1 rate, the number of errored seconds, during a 2-hour, one-way loopback test, is less than 10.
- For systems interfacing at the DS3 rate, the number of errored seconds, during a 2-hour, one-way loopback test, is less than 72.
- The BER is less than 10^{-9} for both the DS1 and DS3 rates. Burst-errored seconds are excluded.
- The frequency of burst-errored seconds, other than those caused by protection switching induced by hard equipment failures, averages less than 4 per day.

Synchronization

BBF2/BBF2B Synchronous Timing Generator (TGS)

The TGS circuit pack meets the specifications of GR-253-CORE, SONET Transport Systems Generic Criteria. The TGS circuit pack supports three timing modes:

- External timing: Locked to external Stratum 3 (±4.6 ppm) or better DS1 reference.
- Line-timing: Locked to recovered clock from an OC-N signal.
- Free-running: Timing derived from high-stability temperature-compensated voltage-controlled crystal oscillator (TCVCXO) with a long-term accuracy of ±15 ppm and temperature stability of ±8.8 ppm (–40°C to +75°C).

Holdover mode is entered on failure of external timing or line-timing reference, providing a temperature stability of ±8.8 ppm (–40°C to +75°C). Holdover capability for 24 hours will be better than ±4.6 ppm.

The DS1 timing output used for network synchronization (BBF2B only) provides long-term accuracy traceable to the OC-N signal.

SONET synchronization messaging is used to output DS1 AIS when clock traceability is lost (Release 5 and later). Jitter on the DS1 output is less than 0.06 unit interval peak-to-peak.

BBF4 Synchronous Timing Generator 3 (TG3)

The TG3 Stratum 3 circuit pack meets the specifications of GR-253-CORE, SONET Transport Systems Generic Criteria. The TG3 circuit pack supports three timing modes:

- External timing: Locked to external Stratum 3 (±4.6 ppm) or better DS1 reference.
- Line-timing: Locked to recovered clock from an OC-N signal.
- Free-running: Timing derived from high-stability temperature-compensated voltage-controlled crystal oscillator (TCVCXO) with a long-term accuracy of ±4.6 ppm and temperature stability of ±2 ppm.

Holdover mode is entered on failure of external timing or line-timing reference, providing a temperature stability of ±2 ppm (–40°C to +75°C) or ± .3 ppm (0°C to +70°C). Holdover capability for 24 hours will be better than ±.37 ppm.

The DS1 timing output used for network synchronization (BBF2B or BBF4) provides long-term accuracy traceable to the OC-N signal.

Protection Switching

Linear Networks

Automatic line switches are initiated by signal fail and signal degrade conditions on the received OC-3 signal and are completed within 50 milliseconds of a signal failure. This signal's BER is calculated from violations of the SONET line overhead B2 parity bytes. Signal fail is declared for incoming LOS, LOF, line AIS, or a BER exceeding 10^{-3}, while a BER exceeding a provisionable threshold between 10^{-5} and 10^{-9} causes a signal degrade to be declared.

Ring Networks

Path protection rings feed a SONET payload (STS or virtual tributary [VT]) from the ring entry point, simultaneously in both rotations of the ring, to the signal's ring exit point. The node that terminates the signal from the ring monitors both ring rotations and is responsible for selecting the signal that has the highest quality based on LOS, path AIS, and path BER performance. On pass-through paths, all detected hard failures (LOS, LOF, LOP, line AIS, STS-1 path AIS, or STS-1 path signal failure based on BER) result in VT AIS insertion in the outgoing signals. This allows the terminating node to be aware of the failure and to switch to protection. Protection switching is completed within 50 milliseconds of failure detection.

Under normal conditions, both incoming SONET path signals to the switch selection point are of high quality, and the signal can be selected from either ring. A failure or a transmission degradation on one of the rings requires that the other ring path be selected. Release 5.1 provides nonrevertive switching to minimize the impact on critical customer services by giving the service provider control, when and if, the critical service should revert to a particular ring. A manual path protection switching command allows switching back to the original path for ease of ring maintenance.

Transient Performance

Power Loss Restart

After system shutdown due to power loss, the system will exhibit a 2-second error free transmission interval which begins within 1 minute of restoration of power.

Transmission Start-Up on Signal Application

The system, after having no signal applied for greater than 1 minute at the DSX-n interface, will exhibit a 2-second error free transmission interval which begins within 5 seconds of the reapplication of a signal.

Delay

Table 11-21 lists the worst-case measured one-way transmission delay within a DDM-2000 OC-3 Multiplexer.

Table 11-21. DDM-2000 OC-3/OC-1 Transmission Delay in Microseconds

	Low-Speed Interface					
Mode (High-Speed)	**OC-3/EC-1 (STS-1)***	**OC-3/EC-1 (VT)***	**DS3**	**DS1**	**OC-1 STS**	**OC-1 VT**
Terminal (OC-3)	7	27	7	40		
EC-1				40		
ADM (OC-3)	7	27	7	100		
Ring (OC-3/OC-12) †	7 †	27 †	7	100	7	27
Ring (OC-1)				100	7	27

* STS-1 or EC-1 cross-connected.

† Ring delay is based on high-speed and low-speed or between main-1 and main-2.

Performance Monitoring

Table 11-22 shows the provisionable range of the thresholds for monitored parameters and, in brackets, the default thresholds. Thresholding of any parameter(s) can be disabled.

Table 11-22. Performance Monitoring Parameters Provisionable via the CIT

Parameter Definition		Threshold Range (Default)		Command
Facility	**Measure**	**Current Quarter Hour**	**Current Day**	**set-pmthres-**
OC-3 Optics	Optical Transmit Power* (21G/21G-U only) Laser Bias Current* (21G/21G-U only)	-1 dB, -2 dB enable/disable	-1 dB, -2 dB enable/disable	**sect** **sect**
OC-12 Section §§	SE Frame Seconds (SEFS)	1-63 [10]	1-4095 [30]	**sect**
OC-3 Section	SE Frame Seconds (SEFS)	1-63 [10]	1-4095 [30]	**sect**
OC-1 Section	SE Frame Seconds (SEFS)	1-63 [10]	1-4095 [30]	**sect**
OC-12 Line §§	B2 Coding Violations (CV) B2 Errored Seconds (ES) B2 Errored Seconds Type A (ESA) B2 Errored Seconds Type B (ESB) B2 Severely Errored Seconds (SES) B2 Unavailable Seconds (UAS) STS Pointer Justification (PJC)	1-55365 [5537] 1-900 [40] 1-900 [30] 1-900 [30] 1-63 [20] 1-63 [30] 1-65535 [60]	1-5315040 [531504] 1-65535 [900] 1-65535 [90] 1-65535 [90] 1-4095 [60] 1-4095 [90] 1-9999999 [5760]	**line** **line** **line** **line** **line** **line** **line**
OC-3 Line	B2 Coding Violations (CV) B2 Errored Seconds (ES) B2 Errored Seconds Type A (ESA) B2 Errored Seconds Type B (ESB) B2 Severely Errored Seconds (SES) B2 Unavailable Seconds (UAS) Line Protection Switch Counts (PSC-L) STS Pointer Justification (PJC) ¶¶	1-13841[1384] 1-900 [40] 1-900 [30] 1-900 [30] 1-63 [20] 1-63 [30] 1-63 [2] 1-65535 [60]	1-1328736 [132874] 1-65535 [900] 1-65535 [90] 1-65535 [90] 1-4095 [60] 1-4095 [90] 1-255 [4] 1-9999999 [5760]	**line** **line** **line** **line** **line** **line** **line** **line**
OC-1 Line	B2 Coding Violations (CV) B2 Errored Seconds (ES) B2 Errored Seconds Type A (ESA) B2 Errored Seconds Type B (ESB) B2 Severely Errored Seconds (SES) B2 Unavailable Seconds (UAS) STS Pointer Justification (PJC) ¶¶	1-4613 [461] 1-900 [40] 1-900 [30] 1-900 [30] 1-63 [20] 1-63 [30] 1-65535 [60]	1-442848 [44285] 1-65535 [900] 1-65535 [90] 1-65535 [90] 1-4095 [60] 1-4095 [90] 1-9999999 [5760]	**line** **line** **line** **line** **line** **line** **line**

Table 11-22. Performance Monitoring Parameters Provisionable via the CIT—*Continued*

Parameter Definition		Threshold Range (Default)		Command
Facility	**Measure**	**Current Quarter Hour**	**Current Day**	**set-pmthres-**
EC-1 Line §	B2 Coding Violations (CV) EC-1 B2 Errored Seconds (ES) B2 Errored Seconds Type A (ESA) B2 Errored Seconds Type B (ESB) B2 Severely Errored Seconds (SES) B2 Unavailable Seconds (UAS) STS Pointer Justification (PJC) ¶¶	1-4613 [461] 1-900 [40] 1-900 [30] 1-900 [30] 1-63 [20] 1-63 [30] 1-65535 [60]	1-442848 [44285] 1-65535 [900] 1-65535 [90] 1-65535 [90] 1-4095 [60] 1-4095 [90] 1-9999999 [5760]	**line** **line** **line** **line** **line** **line** **line**
STS-1 Path	B3 Coding Violations (CV) B3 Errored Seconds (ES) B3 Errored Seconds Type A (ESA) B3 Errored Seconds Type B (ESB) B3 Severely Errored Seconds (SES) B3 Unavailable Seconds (UAS)	1-4510 [451] 1-900 [40] 1-900 [30] 1-900 [30] 1-63 [20] 1-63 [30]	1-432960 [43296] 1-65535 [900] 1-65535 [90] 1-65535 [90] 1-4095 [60] 1-4095 [90]	**sts1** **sts1** **sts1** **sts1** **sts1** **sts1**
DS3 Path ¶	P-Bit Error Counts SE Frame Seconds (SEFS)	1-4026 [403] 1-63 [10]	1-386500 [38650] 1-4095 [30]	**t3** **t3**
Enhanced DS3 Path for P-Bits, F&M Bits, and C-Bits from Fiber and DSX**	CV-P Coding Violations ES-P Errored Seconds SES-P Severely Errored Seconds UAS-P Unavailable Seconds SEFS	1-16383 [40] 1-900 [25] 1-63 [4] 1-63 [10] 1-63 [2]	1-1048575 [3820] 1-65535 [250] 1-4095 [40] 1-4095 [10] 1-4095 [8]	**t3** **t3** **t3** **t3** **t3**
DS3 Line ††	CV-L Coding Violations Errored Seconds, Line (ES-L) Severely Errored Seconds, Line (SES-L)	1-16383 [40] 1-900 [25] 1-63 [4]	1-1048575 [3865] 1-65535 [250] 1-4095 [40]	**t3** **t3** **t3**

Table 11-22. Performance Monitoring Parameters Provisionable via the CIT—*Continued*

Parameter Definition		Threshold Range (Default)		Command
Facility	**Measure**	**Current Quarter Hour**	**Current Day**	**set-pmthres-**
VT1.5 Path †	V5 Errored Seconds (ES) V5 Severely Errored Seconds (SES) V5 Unavailable Seconds (UAS)	1-900 [40] 1-63 [20] 1-63 [30]	1-65535 [900] 1-4095 [60] 1-4095 [90]	**vt1** **vt1** **vt1**
DS1 Path ‡, ‡‡	ES-P Errored Seconds SES-P Severely Errored Seconds UAS-P Unavailable Seconds ES-PFE Errored Seconds SES-PFE Severely Errored Seconds UAS-PFE Unavailable Seconds CV-P (SF) Coding Violations †† CV-P (ESF) Coding Violations †† CV-PFE Coding Violations ††	1-900 [65] 1-63 [10] 1-63 [10] 1-900 [65] 1-63 [10] 1-63 [10] 1-16383 [72] 1-16383 [13296] 1-16383 [13296]	1-65535 [648] 1-4095 [100] 1-4095 [10] 1-65535 [648] 1-4095 [100] 1-4095 [10] 1-1048575 [691] 1-1048575 [132960] 1-1048575 [132960]	**t1** **t1** **t1** **t1** **t1** **t1** **t1** **t1** **t1**
DS1 Line ††, ‡‡	ES-L Line Errored Seconds	1-900 [65]	1-65535 [648]	**t1**

* Threshold is set once for both current quarter hour and current day.

† Release 6.0 and later linear releases, Release 7.0 and later ring releases (feature package option).

‡ Release 5.1 and later ring releases and Release 6.0 and later linear releases (feature package option).

§ Release 5.1 and later ring releases and Release 6.0 and later linear releases.

¶ Prior to Release 7.1.

** From the fiber Release 7.1 and later; from the fiber and DSX Release 7.2 and later. C-Bit option is Release 8.0 and later releases.

†† Release 7.2 and later releases.

‡‡ Release 9.1 and later in OC-3 systems support current quarter-hour thresholding and reporting of DS1 PM.

§§ Applicable only when using the 24G-U/24H-U/29G-U/29H-U OLIU in main slot.

¶¶ Release 11.0 and later.

Operations Interfaces

This section presents the operation interfaces that are required to support technician access to the system and allow alarms and status information generated by the system to be reported. The local operation interfaces include the CIT interface, the user panel, and the equipment indicators. The DDM-2000 OC-3 Multiplexer supports office alarms, parallel telemetry, user-definable miscellaneous discretes, serial (TBOS) telemetry interfaces, and TL1/X.25.

Craft Interface Terminal (CIT)

The system provides two EIA-232-D compatible CIT interfaces — a front access interface, configured as data communications equipment (DCE), and a rear access CIT interface, configured as data terminal equipment (DTE), to allow a permanent modem connection without requiring a null modem. A null modem is required to connect an ASCII terminal to the DTE interface or a modem to the DCE interface. The CIT interfaces provide data rates of 300, 1200, 2400, 4800, 9600, and 19,200 baud.

Both CIT interfaces operate full duplex using 1 start bit, 8 data bits, and 1 stop bit. Table 11-23 describes the pins supported on the CIT interfaces.

Table 11-23. CIT Interface Pin Connections

EIA-232-D Pin	Front Access CIT (DCE)	Rear Access CIT (DTE)
Pin 2 — Circuit BA Transmitted Data	carries data from terminal to DDM-2000 OC-3	carries data from DDM-2000 OC-3 to modem or terminal
Pin 3 — Circuit BB Received Data	carries data from DDM-2000 OC-3 to terminal	carries data from modem or terminal to DDM-2000 OC-3
Pin 7 — Circuit AB Signal Ground	signal ground	signal ground
Pin 8 — Circuit CF Received Line Signal Detector	not used	indicates to DDM-2000 OC-3 that modem or terminal is connected
Pin 20 — Circuit CD DTE Ready	indicates to DDM-2000 OC-3 that modem or terminal is connected	indicates to modem or terminal that DDM-2000 OC-3 is connected (always ON when SYSCTL is powered)

A CIT is recommended for installation, maintenance and administrative activities. A personal computer (PC) is required for software download and to run the CPro-2000 software. The DDM-2000 OC-3 Multiplexer CIT port (mounted on the user panel) is a standard EIA-232-D (supersedes RS-232C specification) interface configured as DCE for direct connection to a CIT. The CIT port will support rates of 300, 1200, 2400, 4800, 9600, and 19,200 baud and should be compatible with most *ANSI* 3.64 ASCII terminals; however, it is optimized for standard screens with display areas of 24 lines by 72 (or more) columns. A pager function is included in the DDM-2000 OC-3 Multiplexer to accommodate screen lengths from 3 lines to 150 lines.

Those CITs compatible with DDM-1000 (see 363-206-100 for a list of DDM-1000 compatible terminals) should be directly compatible with the DDM-2000 OC-3 Multiplexer, although some may not be as convenient to use with the DDM-2000 OC-3 Multiplexer.

If the multishelf bus cables (ED-8C724-20, G354 or G356) are connected between shelves in a bay, a CIT may then be connected to the user panel CIT port on any shelf and may address any other shelf in that bay (as well as the remote terminal shelves associated with that shelf in the bay). Any terminal compatible with the *ANSI* 3.64 standard should be compatible with the DDM-2000 OC-3 Multiplexer.

Personal Computer (PC) Specifications for Software Download

The PC used for software download should have:

- A minimum of 640K of random access memory (RAM)
- *MS-DOS*[*] version 2.0 or newer
- Hard disk
- At least one floppy disk drive of 360K or larger capacity. Although the disk drive may accommodate either floppy or hard disk, a hard disk is preferred for its better performance. The disk requirement is met with most portable *MS-DOS* PCs with a single 3.5-inch disk. An *MS-DOS* PC with a hard disk and either a 3.5-inch 1.44M floppy disk may also be used.
- Windows NT* available to work with the OC-3 releases 7.2 and earlier and 13.0 and later and OC-12 releases 7.0 and later.

* Registered trademark of Microsoft Corporation.

Compatible Modems

A compatible modem must meet the following minimum requirements:

- 300, 1200, 2400, 4800, 9600, or 19,200 baud
- Full duplex
- 8 data bits
- No parity bits
- 1 start bit
- 1 stop bit
- No flow control.

The following stand-alone modems meet the modem requirements and can be used with the DDM-2000 system. *Western Electric*® 103-compatible and 212A-compatible modems are also suitable for use with the DDM-2000 system. This is not an exhaustive list of compatible modems:

- *Paradyne*® *2224-CEO modem (at 1200 and 2400 baud)
- *Paradyne* 2224 modem (at 1200 and 2400 baud)
- *Paradyne* 4024 modem (at 1200 and 2400 baud)
- *Paradyne* 2296 modem (at 4800 and 9600 baud)
- Hayes *V-series*† Smartmodems
- *Penril*‡ Alliance V.32 modem.

The *NCR* 3170 computer and the AT&T *Safari*® computer have a built-in modem and meet the modem requirements.

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* Trademark of AT&T.
† Trademark of Hayes Microcomputer Products, Inc.
‡ Registered trademark of Penril Corporation.

CPro-2000 Graphical User Interface and Provisioning Tool

The CPro-2000 Graphical User Interface and Provisioning Tool is a *Microsoft*[*] *Windows* based user interface that can optionally be used with the DDM-2000 OC-3 Multiplexer. The tool simplifies and mechanizes administration, maintenance, and provisioning operations. CPro-2000 supports DDM-2000 FiberReach, DDM-2000 OC-3 Multiplexers, DDM-2000 OC-12 Multiplexers, and FT-2000 OC-48 Lightwave Systems. With the tool a user can:

- Display and control cross-connections at each NE in a ring and the entire ring, including dual ring interworking (DRI) (for example, drop and continue paths at DRI nodes).
- Obtain and display graphical images of the ring configuration, equipment, and cross-connections.
- Perform an analysis of the ring to detect provisioning errors.
- Retrieve and store data about a selected NE.
- Backup and restore provisioning information including cross-connections, DS1 port options, DS3 port options, EC-1 port options, and OC-3 line options.

A minimum platform configuration is:

- 486 SX *IBM*[†] compatible desktop or laptop PC
- Disk drive — one 1.44 Megabyte (3.5 inch)
- Hard disk with at least 40 Megabytes of available space
- 8 Megabyte RAM
- *MS-DOS* operating system version 5.0 or later
- *Windows* NT or *Windows* 95
- Serial port (EIA-232-D) — configured as COM1 or COM2
- Mouse
- VGA color monitor.

CPro-2000 has been tested with AT&T, *NCR*, *IBM*, *NEC*[‡], and *Gateway*-2000[§] personal computers. For more information, see 365-576-130, *CPro-2000 User Manual*.

* Microsoft is a registered trademark and Windows is a trademark of Microsoft Corporation.
† IBM is a registered trademark of International Business Machines Corporation.
‡ NEC is a registered trademark of NEC Corporation.
§ Gateway 2000 is a trademark of Gateway 2000, Inc.

User Panel

The user panel contains red LEDs for CR and MJ alarms, yellow LEDs for MN and PMN alarms, and for abnormal (ABN), far-end activity (FE-ACTY), and near end activity (NE-ACTY) status. These LEDs are used in conjunction with the far-end identification (FE-ID) 7-segment display on the front panel of the adjacent SYSCTL circuit pack to provide CIT-less single-ended operations.

A green PWR ON LED is lighted when the shelf is receiving –48 V power. A green ACO LED is lighted when the ACO function is active.

The FE SEL test, ACO/TEST, and UPD/INIT push-buttons are provided to control system operation.

Equipment Indicators

A red LED FAULT indicator is provided on all circuit packs. A green LED ACTIVE indicator is provided on all 1x1 protected circuit packs to indicate which circuit packs are actively carrying traffic.

Office Alarms

The office alarms interface is a set of discrete relays that control office audible and visual alarms. Separate relays handle CR, MJ, and MN alarms. Each contact closure is rated at 1 A, 60 V maximum. The CR and MJ alarms can be wire-ORed. The CR alarm relays are fail safe against unprotected power failures.

Serial Telemetry

Serial telemetry is provided using the telemetry byte-oriented serial (TBOS) protocol. TBOS telemetry provides detailed alarm, status, and control (AS&C) information to and from a remote maintenance center via a 2400 baud RS-422 port. The AS&C TBOS link can be shared among multiple DDM-2000 OC-3 Multiplexer shelves. A TBOS link can support up to eight displays or four OC-3 point-to-point networks.

Parallel Telemetry

Parallel telemetry brings a minimum set of alarm and status information to an operations center. Four alarm closures indicate CR, MJ, MN, and PMN alarms.

The following status closures identify alarms as far-end or near-end and as failures on received OC-3 signals or incoming low-speed interfaces, and provide system identification when alarms are paralleled among several shelves in a bay.

- Near-end (NE) status
- Far-end (FE) status (six closures)
- Carrier line failure (CLF) status
- Incoming (INC) status
- System identification (SID) status
- ACO output (ACOO).

The parallel telemetry outputs tolerate –60 V maximum open circuit voltage and 35 mA maximum current. Transient voltages up to –135 V are tolerated for up to 1 ms. The parallel telemetry ACO input provides –48 V nominal (–60 V maximum) open circuit voltage and 2 mA maximum current.

The parallel telemetry output closures generated by the optoisolator require external voltage and ground to operate.

User-Definable Miscellaneous Discrete Environmental Alarms and Controls

The user-definable miscellaneous discrete environmental alarm and control interface allows the DDM-2000 OC-3 Multiplexer to monitor and control co-located equipment at the remote site. At the remote terminal (RT) site, 21 alarm or status environmental inputs can monitor environmental conditions (for example, open door, high temp); these inputs are activated by contact closures. The 15th environmental alarm or status input is provided to monitor the condition of the power shelf and fans at the RT site; this closure is activated by –48 V DC. Prior to Release 8.0, only 15 discretes are available. Four environmental control outputs are provided to control external equipment (for example, pumps or generators). The miscellaneous discrete outputs (control outputs at an RT, alarm/status outputs at a CO) tolerate –60 V maximum open circuit voltage and 35 mA maximum current. Transient voltages up to –135 V are tolerated for up to 1 ms. The miscellaneous discrete inputs (control inputs at a CO, alarm/status inputs in an RT) provide –48 V nominal (–60 V maximum) open circuit voltage and 2 mA maximum current. The miscellaneous discrete output closures generated by the optoisolator require external voltage and ground to operate.

The 21 alarm or status inputs can be reported through a TL1/X.25 interface. The first 10 of these can also be reported through discrete telemetry outputs at the CO end. The first 15 of these inputs can also be reported through TBOS scan points.

Order Wire

The DDM-2000 OC-3 Multiplexer uses the E1 byte in the SONET overhead and provides a 64 kb/s complementary metal oxide semiconductor (CMOS) or transistor-transistor logic (TTL) compatible interface to an external order wire shelf to provide point-to-point voice communication between DDM-2000 OC-3 systems.

If the DDM-2000 OC-3 Multiplexer is using R8.1 or R9.1, a proprietary MUX order wire capability is available for use in *MegaStar* 2000. The MUX order wire mode provides access to the E1, E2, and F1 SONET overhead bytes in a proprietary 1.544 Mb/s data stream for use with the Harris-Farinon mini-CSU equipment.

The DDM-2000 OC-3 Multiplexer system has been tested with the *DANTEL*[*] Order wire Assembly A18-04588-02.

See the "OC-3 Ordering — Miscellaneous Equipment and Tools" section for ordering information.

* DANTEL is a registered trademark of Dantel, Inc.

TL1/X.25 Interface

The DDM-2000 Multiplexer supports a TL1/X.25 interface for communication between local and remote DDM-2000s and alarm surveillance and provisioning operations systems (OS) such as Telcordia Technologies' Network Monitoring and Analysis (NMA) and Operations Systems/Intelligent Network Element (OPS/INE) OSs. The DDM-2000 OC-3 Multiplexer TL1/X.25 interface is based on Telcordia Technologies TR-TSY-000833, Issue 5. In Releases 8.0, 9.0 and later, the DDM-2000 OC-3 Multiplexer supports up to nine X.25 permanent virtual circuits (PVCs) and up to nine switched virtual circuits (SVCs) assigned by default as shown in Table 11-24. The user may assign a maximum of nine VCs using any combination of PVCs and SVCs.

Table 11-24. TL1/X.25 Interface — Default VC Assignments

PVC ID	SVC ID	Logical Group #	Logical Channel #	Use
1		0	1	User Definable ‡
2		0	2	Autonomous Maintenance Messages, (User Definable ‡)
3*		0	3	Autonomous Provisioning Messages (REPT DBCHG), (User Definable ‡)
	1†	0	16	Autonomous Maintenance and Provisioning Messages §, (User Definable ‡)
	2 ‡	0	17	User Definable ‡
	3 ‡	0	18	User Definable ‡
	4 ‡	0	19	User Definable ‡
	5 ‡	0	20	User Definable ‡
	6 ‡	0	21	User Definable ‡

* Release 6.1 (linear), 5.1 (rings), and later

† Release 6.2 (linear), 7.1 (rings), and later

‡ Release 8.0 (linear), 9.0 (rings), and later

§ Release 6.2 (linear), 7.1 and 7.2 (rings) only.

All VCs support command/response messages (except PVC #2 prior to Release 6.0, is limited to autonomous maintenance messages only). The autonomous maintenance messages are all TL1 autonomous messages except REPT DBCHG.

If the default assignments in Table 11-24 do not meet the user's OS needs, Releases 8.0, 9.0 and later of DDM-2000 OC-3 allows users to specify the routing of TL1 autonomous message types to VCs. This is done in two steps:

1. Each TL1 autonomous message type (e.g., REPT ALM, REPT DBCHG, REPT PM, etc.) can be mapped to any OS type (using the ent-tl1msgmap command at every NE in the subnetwork). The OS types are tl1Maintenance, tl1MemoryAdministration, tl1test, tl1PeerComm, tl1Other1 and tl1Other2.

2. Each OS type can be mapped to any of the VCs (using the ent-osacmap command at the TL1 GNE). The combination of Step #1 (mapping TL1 autonomous message types to OS types) and Step #2 (mapping OS types to VCs) accomplishes the desired mapping of TL1 autonomous message types to VCs.

At the packet layer, the DDM-2000 OC-3 Multiplexer is configured as a passive DTE with the following parameters as shown in Table 11-25.

Table 11-25. TL1/X.25 Interface — X.25 Packet Layer Parameters

Parameter	Value
Packet Size	128 bytes* or 256 bytes
Window Size	2 packets
D bit support	NO
M bit support	YES

* Release 8.0 (linear), 7.2 (rings) and later

At the link layer, the DDM-2000 OC-3 Multiplexer uses the standard link access procedure "B" (LAPB) protocol with the following parameters as shown in Table 11-26.

Table 11-26. TL1/X.25 Interface — LAPB Link Layer Parameters

Parameter	Value
Maximum Frame Size	2104 bits
Module	8
Window Size	7 frames
n2	7 retries
T1	3 seconds
T3*	20 seconds

* Release 3.2 and later.

The DDM-2000 OC-3 Multiplexer uses synchronous, full duplex, continuous carrier communication. Data rates of 1200, 2400, 4800, 9600, and 19,200 baud are supported. The EIA-232-D interface is configured as DTE, using the pin connections specified in Table 11-27.

Table 11-27. TL1/X.25 Interface — EIA-232-D Pin Connections

Pin	Description
2	Transmitted Data
3	Received Data
4	Request to Send
5	Clear to Send
6	DCE Ready
7	Signal Ground
8	Received Line Signal Detector
15	Transmitter Signal Element Timing (DCE to DTE)
17	Receiver Signal Element Timing (DCE to DTE)
20	DTE Ready*

* DTE is always on when the DDM-2000 OC-3 Multiplexer is powered.

Physical Specifications

Shelf Physical Characteristics

- Dimensions: 8.5 in. H x 21.25 in. W x 12 in. D (Group 1 or Group 3)
  Dimensions: 8.5 in. H x 21.25 in. W x 13.25 in. D (Group 4)
- Weight (Max.): 44 lb. (20 kg)
- Appearance: Coordinated with other equipment in the Lucent 2000 Product Family.

Network Bay and Cabinet Mounting

The DDM-2000 OC-3 Multiplexer can be mounted in both ED-8C500 and ED-8C501 network bay frames. A maximum of six shelves may be mounted in a 7-foot bay. In addition to bay mounting, the DDM-2000 OC-3 Multiplexer can be packaged with other equipment in 80A, 80D, and 80E cabinets, 51A cabinets, 90-type business remote terminals, controlled environment vaults (CEVs), or huts.

NOTE:
The mounting brackets on the DDM-2000 OC-3, OC-12, heat baffle, and fan shelf are designed to allow for mounting in standard 23-inch wide network bay frames and 23-inch wide EIA-type bay frames.

Environmental Specifications

Temperature and Humidity

A DDM-2000 OC-3 Multiplexer shelf meets Telcordia Technologies Network Equipment Building System (NEBS*) requirements for use in CO environments without fans.

A fan shelf is required in uncontrolled environments or cabinet applications either above or below any DDM-2000 OC-3 shelf. Refer to ED-8C724-10, "Typical Bay Arrangements," for detailed information on placement of fans and heat baffles in typical bay arrangements.

The DDM-2000 OC-3 Multiplexer operates in uncontrolled environments at temperatures of –40°C to +75°C and humidity of 5 to 95 percent (noncondensing). Forced convection cooling (fans) is required when the air inlet temperature is above 50°C. The DDM-2000 OC-3 Multiplexer provides optional control and alarming of the 2-type fan units used in Lucent cabinets and alarming of the DDM-2000 fan shelf.

EMC Requirements

The DDM-2000 OC-3 Multiplexer has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio-frequency energy, and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residence is likely to cause harmful interference in which case the user will be required to correct the interference at the user's own expense.

* "*NEBS Generic Equipment Requirements*," TR-NWT-000063, Issue 4.

Earthquake Requirements

The DDM-2000 OC-3 Multiplexer meets the earthquake requirements defined in Telcordia Technologies TR-NWT-000063, Issue 4, and Pacific Bell Standard PBS-000-102PT. Installations in Zone 4 regions require the ED-8C800-50 or ED-8C801-50 bay frame. Drawing ED-8C800-70 provides ordering and engineering application information for these frames.

Fire Resistance

The DDM-2000 OC-3 Multiplexer meets the ignitability requirements specified in ANSI T1.307-1997. In addition, the DDM-2000 OC-3 Multiplexer meets the fire resistance requirements of *UL* 1459, 2nd Edition.

Underwriters Laboratories

The DDM-2000 OC-3 Multiplexer is *UL* recognized for restricted access installations in business and customer premises applications installed in accordance with Articles 110-16 and 110-17 of the *National Electric Code*[*], *ANSI*/NFPA Number 70-87. Other installations exempt from the requirements of the *National Electric Code* may be engineered according to the accepted practices of the local telecommunications utility.

Canadian Standards Association

The DDM-2000 OC-3 Multiplexer has been certified by the Canadian Standards Association per standard C22.2 Number 225-M90.

* Registered trademark of the National Fire Protection Association, Inc.

Power Requirements

Shelf Fuses

The two –48 V feeders (A and B) are required for each DDM-2000 OC-3 shelf. Shelf power is protected by 5-amp fuses provided with the shelf.

It is recommended that a supply of spare fuses be provided at DDM-2000 OC-3 Multiplexer locations. Fuses for the Group 1 shelf may be ordered through Lucent using COMCODE 405697442 or through Littlefuse, Inc., 800 East Northwest Highway, Des Plaines, IL 60016, or call 708-824-1188. Order:

Fuse, 5-amp, Part No. 334005.

Fuses and a fuse extraction tool for the Group 3 or Group 4 shelf may be ordered through Lucent using COMCODE 406203976 for fuses and COMCODE 406420273 for the extraction tool or through SAN-O Industrial Corporation, 91-3 Colin Drive, Sherwood Corporation Center, Holbrook, NY 11741 or by calling 516-472-6666 and ordering.

Fuse, 5-amp, Part No. AX-1-5A or
Fuse Extraction Tool, Part No. F-0431.

Power Dissipation

Table 11-28 lists the power dissipation and current drains for the listed configurations.

Table 11-28. Power Dissipation and Current Drains

Configuration	Power Dissipation (Watts)	DC Current Drains (Amps) List 1 (-48 V DC)	DC Current Drains (Amps) List 2 (-40 V DC)
OC-3 terminating shelf with 24 DS1 circuit packs (84 DS1s)	66	1.4	1.7
OC-3 terminating shelf with 24 DS1PM circuit packs (84 DS1s)	79	1.6	2.0
OC-3 terminating shelf with 6 DS3 circuit packs (3 DS3s)	58	1.2	1.5
OC-3 STS-1 add/drop shelf with 16 DS1 circuit packs (56 DS1s)	80	1.7	2.0
OC-3 hub shelf with 8 21G/21G-U OLIU circuit packs	100	2.1	2.5
OC-3 DS1 add/drop shelf with 16 DS1PM circuit packs (56 DS1s)	87	1.8	2.2
OC-3 DS1 add/drop shelf with 8 22F OLIU circuit packs	114	2.4	2.9
EC-1 electrical multiplexer shelf with 24 DS1 circuit packs (84 DS1s)	66	1.4	1.7
EC-1 electrical multiplexer shelf with 24 DS1PM circuit packs (84 DS1s)	73	1.5	1.8
OC-3 terminating shelf with 6 STS1E circuit packs (3 EC-1s)	60	1.3	1.5
OC-3 DS1 self-healing ring shelf with 24 DS1 circuit packs (84 DS1s)	73	1.5	1.8
OC-3 DS1 self-healing ring shelf with 24 DS1PM circuit packs (84 DS1s)	80	1.7	2.0
OC-3 DS1 self-healing ring shelf with 24G-U/24H-U OLIU and 24 DS1 circuit packs (84 DS1s)	73	1.5	1.8
OC-3 DS1 self-healing ring shelf with 24G-U/24H-U OLIU and 24 DS1PM circuit packs (84 DS1s)	88	1.8	2.25
OC-3 self-healing ring shelf with 6 STS1E circuit packs (3 EC-1s)	63	1.3	1.6

Table 11-28. Power Dissipation and Current Drains—*Continued*

Configuration	Power Dissipation (Watts)	DC Current Drains (Amps)	
		List 1 (-48 V DC)	List 2 (-40 V DC)
OC-3 terminating shelf with 24 DS1 circuit packs (84 DS1s)	66	1.4	1.7
OC-3 self-healing ring shelf with 2 OC-3 optical extensions (22G-U/22G2-U) and 8 DS1PM circuit packs (28 DS1s)	102	2.1	2.5
OC-3 self-healing ring shelf with 6 27G-U/27G2-U dual OC1 OLIUs	111	2.3	2.8
OC-3 DS1 self-healing ring shelf with 29G-U/29H-U OLIU and 24 DS1 circuit packs (84 DS1s)	78	1.6	1.9
OC-3 DS1 self-healing ring shelf with 29G-U/29H-U OLIU and 24 DS1PM circuit packs (84 DS1s)	93	1.9	2.3
DDM-2000 Fan shelf	53	1.1	1.3

The following items should be noted:

- The DDM-2000 OC-3 shelf accommodates two –48 V power feeders ("A" and "B" office power feeders).
- Loss of one power feeder does not cause a loss of service.
- All supply voltages other than –48V required by DDM-2000 OC-3 Multiplexer are generated by DC-to-DC converters within the DDM-2000 OC-3 shelf.
- The DDM-2000 OC-3 Multiplexer meets all performance requirements when the DC input voltage varies between –40.0 V and –60.0 V.
- The DDM-2000 OC-3 Multiplexer tolerates DC input voltages between 0 V and –60 V without damage.
- The DDM-2000 OC-3 Multiplexer complies with electrical noise tolerance requirements in Section 13.2 of TR-TSY-000499.

CAUTION:
This information is for a typical application only. Consult 801-525-168, DDM-2000 Floor Plan Data Sheets, and T82046-30, Power Systems DC Distribution Circuit for Digital Transmission System, for proper engineering of battery plant and feeders.

DDM-2000 OC-3 Reliability

Summary

This section describes the Telcordia Technologies reliability requirements that apply to the DDM-2000 OC-3 Multiplexer and the calculations used to predict how the DDM-2000 OC-3 Multiplexer meets those standards.

The DDM-2000 OC-3 Multiplexer meets all the applicable Telcordia Technologies reliability requirements that cover transmission availability, OS availability, optical module maintenance, and infant mortality. A summary of the reliability predictions and requirements is shown in Table 11-29. The applicable Telcordia Technologies requirements and objectives were clarified through interactions with Telcordia Technologies during their audit of the DDM-2000 OC-3 Multiplexer. The basis for these requirements comes from TA-TSY-000418, "*Generic Reliability Assurance Requirements for Fiber Optic Transport Systems*." The method and assumptions used to calculate DDM-2000 OC-3 Multiplexer reliability predictions are described in the following paragraphs. Each paragraph is devoted to one of the reliability parameters which must meet a Telcordia Technologies requirement or objective.

Transmission Availability

Telcordia Technologies *requirements* state that the probability of a hardware caused outage on a two-way channel within a SONET multiplexer should be less than 1.75 minutes per year in a CO environment[*] and 5.25 minutes per year in a RT environment.[†] Telcordia Technologies *objectives* for outages are 0.25 minutes per year for the CO[‡] and 0.75 minutes per year for RT environments.[§]

The outage requirements and objectives apply to any part of the product needed to process an incoming high-speed or low-speed signal (DS1 to OC-3 or OC-3 to DS1). An outage is defined, for this and all other outage requirements, as any 1-second interval with a bit error rate of 10^{-3} or worse.[¶] The predicted hardware outages for various configurations of the DDM-2000 OC-3 system are given in Table 11-29.

* TA-NWT-000418, Issue 3, November 1991, p. 17.
† TA-NWT-000418, Issue 3, November 1991, p. 28.
‡ TA-NWT-000418, Issue 3, November 1991, p. 18.
§ TA-NWT-000418, Issue 3, November 1991, p. 28.
¶ TR-TSY-000009, Issue 1, May 1986, p. 4-11.

A Markov model was used to calculate the predicted system outage. The model assumes a mean time to repair of 2 hours for the CO environment and 4 hours for the RT environment. Individual circuit pack failure rates used in the model were calculated using the method described in TR-TSY-000332, Issue 4, "*Reliability Prediction Procedure for Electronic Equipment (RPP)*." A summary of the circuit pack and fan shelf failure rates is shown in Table and Table 11-31, respectively.

Operation System Interface Availability

The Telcordia Technologies objective states that the OS outage should be less than 28 minutes per year (50 percent hardware, 50 percent software).[*] Therefore, the objective applies to the TBOS and TL1/X.25 interfaces. This objective applies to circuitry needed to maintain communication from the DDM-2000 OC-3 Multiplexer to the CO's telemetry equipment for access by an OS. Since the OS interface is used in the CO, the reliability model assumes the mean time to repair is 2 hours and the environmental factor is 1.0. Table 11-29 lists the predicted outages for the TBOS and TL1/X.25 interfaces.

Optical Module Maintenance Objective

According to Telcordia Technologies, the objective for mean time between failure (MTBF) of a one-way regenerator is a minimum of four years[†]. A regenerator is defined as any circuit pack that performs the electrical-to-optical and optical-to-electrical conversion. Table lists the failure rate and MTBFs of the OLIU circuit packs. All OLIU circuit packs meet Telcordia Technologies objectives.

* TA-NWT-000418, Issue 3, November 1991, p. 36.

† TA-NWT-000418, Issue 3, November 1991, p. 37.

Infant Mortality

Telcordia Technologies requires that the number of circuit pack failures in the first year of operation should not exceed 2.5 times the number of failures per year beyond the first year. The ratio of first year failures to failures in subsequent years is known as the infant mortality factor (IMF). The requirement is to have an IMF of less than 2.5*.

DDM-2000 OC-3 Multiplexer circuit packs are subjected to an environmental stress testing (EST) program. The purpose of the program is to eliminate early life failures, conduct failure mode analysis on defective circuit packs, and use corrective action to make the product more reliable. All new circuit pack codes in manufacturing are subjected to EST. However, based on field return data, when the early life failures for any circuit pack codes have been minimal and the infant mortality factor is below 2.5, these circuit pack codes may be subjected only to sampling EST.

* TA-NWT-000418, Issue 3, November 1991, p. 40.

DDM-2000 OC-3 System Reliability Predictions

Table 11-29. DDM-2000 OC-3 System Reliability Prediction (Note 1)

Application	Environment (Note 2)	Telcordia Criteria (Note 3)		Prediction (Outage, min/yr)	MTBF Years (Note 4)
		Requirement	Objective		
DS1 to OC-3	CO	1.75	0.25	0.0464	2587
DS1 to OC-3	RT	5.25	0.75	0.1395	1716
DS3 to OC-3	CO	1.75	0.25	0.0219	5474
DS3 to OC-3	RT	5.25	0.75	0.0662	3608
OC-3 to OC-3	CO	1.75	0.25	0.00013	706329
OC-3 to OC-3	RT	5.25	0.75	0.00115	16,120
EC-1 to OC-3	CO	1.75	0.25	0.0220	5452
EC-1 to OC-3	RT	5.25	0.75	0.0665	3589
DS1 to EC-1	CO	1.75	0.25	0.0647	1853
DS1 to EC-1	RT	5.25	0.75	0.1944	1233
DS1 to OC-1	CO	1.75	0.25	0.0464	2585
DS1 to OC-1	RT	5.25	0.75	0.1396	1714
OC-1 to OC-3	CO	1.75	0.25	0.00015	617467
OC-1 to OC-3	RT	5.25	0.75	0.00131	137227
DS1 to OC-12	CO	1.75	0.25	0.0464	2587
DS1 to OC-12	RT	5.25	0.75	0.1395	1717
OC-12 to OC-12	CO			4.373	27
OC-12 to OC-12	RT			13.118	18
OS Interface TBOS	CO		14.00	8.97	13
OS Interface TL1/X.25	CO		14.00	8.97	13

Example:
The unavailability of one 2-way DS3 channel within one DDM-2000 OC-3 system configured to multiplex DS3 to OC-3, located in an uncontrolled environment, is 0.0662 minutes per year (that is, fraction of time per year when the DS3 channel is unavailable). The mean time between outage of the DS3 channel is 3608 years (that is, average length of time until a DS3 outage occurs).

Notes:

1. Hardware failure rates are calculated per the RPP method, TR-NWT-000332, Issue 6, "Reliability Prediction Procedure."
2. The environmental factor for the CO = 1.0 and for the RT = 1.5, per TR-NWT-000332, Issue 4, "Reliability Prediction Procedure."

3. Telcordia Technologies criteria (Outage Requirements and Objectives) is based on TA-TSY-000418,
Issue 3, "Generic Reliability Assurance Requirements for Fiber Optic Transport Systems." Outage is in minutes per year.
4. Mean time to repair is assumed to be 2 hours for the CO and 4 hours for RT environments.

Table 11-30. DDM-2000 OC-3 Circuit Pack Reliability (Note 1)

	CO		RT	
Circuit Pack	FITS (Note 2)	MTBF (Years)	FITS (Note 2)	MTBF (Years)
BBF1B (DS1)	859	132.8	88.5	93
BBF2B (TGS)	1935	59.0	2903	39.3
BBF2C (TGS)	2345	48.68	3518	32.45
BBF3 (DS1PM)	1310	87.1	1965	58.1
BBF3B (DS1PM)	1235	92.4	1853	61.6
BBF4 (TG3)	2311	49.40	3467	32.93
BBF6 (T1EXT)	1427	80.0	2138	53.39
BBF9 (IMA-LAN)	2037	56.04	3056	37.35
BBF10 (IMA-LAN)	2277	50.13	3416	33.42
BBF8 (HDSL)	5216	21.9	7824	14.6
BBG2 (MXRVO)	570	200.1	855	133.4
BBG2B (MXRVO)	820	139.21	1230	92.81
BBG4 (DS3)	902	126.5	1353	84.3
BBG4B (DS3)	1056	108.0	1584	72.0
BBG5 (SYSCTL)	3032	37.6	4548	25.1
BBG6 (STS1E)	1422	80.2	2133	53.5
BBG7 (OHCTL)	2001	57.0	3002	38.0
BBG8 (SYSCTL)	4505	25.3	6758	16.9
BBG8B (SYSCTL)	4442	25.7	6663	17.1
BBG9 (OHCTL)	4084	27.9	6126	18.6
BBG10 (OHCTL)	4409	25.9	6614	17.2
BBG19 (DS3)	729	156.5	1094	104.3
BBG20 (TMUX)	3088	36.9	4632	24.6
21D (IS-3 OLIU)	1422	80.2	2133	53.5
21D-U (IS-3 OLIU)	1355	84.2	2033	56.1
21G (OLIU)	6103	18.7	9155	12.5
21G-U (OLIU)	6083	18.8	9125	12.5

Table 11-30. DDM-2000 OC-3 Circuit Pack Reliability (Note 1)—*Continued*

	CO		RT	
Circuit Pack	**FITS (Note 2)**	**MTBF (Years)**	**FITS (Note 2)**	**MTBF (Years)**
21G2-U (OLIU)	3714	30.7	5571	20.5
21G3-U (OLIU)	1768	64.57	2652	43.04
22D-U (IS-3 OLIU)	1959	58.2	2939	38.8
22F (OLIU)	2441	46.7	3662	31.2
22F-U (OLIU)	2519	45.3	3779	30.2
22F2-U (OLIU)	2033	56.1	3050	37.4
22G-U (OLIU)	2439	46.8	3659	31.2
22G2-U (OLIU)	2197	51.9	3296	34.6
22G3-U (OLIU)	3533	32.8	5300	21.5
22G4-U (OLIU)	1426	80.05	2139	53.37
24G-U (OLIU)	2080	54.8	3120	36.6
24H-U (OLIU)	2388	47.80	3582	31.87
26G2-U (OLIU)	2575	44.3	3863	29.5
27G-U (Dual OC-1 OLIU)	2857	39.9	4286	26.6
27G2-U (Dual OC-1 OLIU)	2823	40.4	4235	26.9
29G-U (OLIU)	3264	34.9	4896	23.3
29H-U (OLIU)	3049	37.4	4574	24.9

Notes:

1. Calculations are based on Telcordia Technologies RPP Issue 6 data. All KS and Lucent components considered as quality level III. All components evaluated at 40°C ambient and 50 percent electrical stress.
2. FITS is the number of failures per billion hours of operation (10^9).

Table 11-31. DDM-2000 Fan Shelf Steady State Failure Rates (Based on Telcordia Technologies RPP, Issue 6, Data)

	Failures /10^9 hrs.	
DDM-2000 Fan Shelf	**RPP Prediction**	**MTBF (years)**
ED-8C733-30,G7 Fan Shelf	9879 *	11.56
ED-8C733-30,G6 Fan Unit	2000	57.08

* Includes failure rates for individual fan units.

DDM-2000 OC-12 Multiplexer

This section contains the technical specifications for the DDM-2000 OC-12 Multiplexer.

External Transmission Interfaces

The DDM-2000 OC-12 Multiplexer transmission interfaces adhere to industry standards as listed in Table 11-32.

Table 11-32. Transmission Interface Standards

Interface	Standard	Comments
DS3 low-speed	*ANSI* * T1.102-1993, TR-499 Iss. 5	VMR, VM, or clear channel
EC-1	*ANSI* T1.102-1993 & TR-253, Iss. 2	
OC-3	*ANSI* T1.106/88, *ANSI* T1.105/91 TR-253, Iss. 2, TR-496, Iss. 3	
OC-12	*ANSI* T1.106/88, *ANSI* T1.105/91 TR-253, Iss. 2, TR-496, Iss. 3	

* Registered trademark of American National Standards Institute.

Electrical Interfaces

The DDM-2000 OC-12 Multiplexer supports DS3 and EC-1 electrical low-speed interfaces.

BBG11/BBG11B Triple DS3 Low Speed (3DS3)

- Electrical Specification

  The low-speed DS3 interface transmits/receives a standard electrical DS3 signal as specified in *ANSI* T1.102-1993, Section 5 (44.736 Mb/s rate, DSX-3 interconnect specification, bipolar 3-zero substitution [B3ZS] encoding). However, the signal does not have to contain a standard DS3 frame.

  Line build-out is provisionable as follows:

  — 734A/D: Up to 450 ft.

  — 735A: Up to 250 ft.

- Format Specification

  The DS3 low-speed interface provides clear channel transport of any DSX-3 compatible signal (M13 mode, framed clear channel, unframed clear channel). Thus, there are no format requirements on this interface.

- Alarm Thresholding

  The following parameters are monitored at the DS3 interface to the DSX-3:

  — Loss of signal (LOS)

  — Line coding violations (CV-L).

  The alarm level for each of the monitored parameters can be provisioned to CR, MJ, MN or status. B3ZS coding violation failure threshold is user settable to 10^{-3} or 10^{-6} BER.

- Performance Monitoring (see Table 11-41)

  — DS3 Parity Errors (P-bits)

  DDM-2000 OC-12 Multiplexers provide for DS3 P-bit violation monitoring and removal based on the provisioning mode of the DS3 low-speed interface. Table 11-33 defines P-bit monitoring and correction actions in each of the DS3 modes.

  — Severely Errored Frame Seconds (SEFS)

Table 11-33. DS3 Performance Monitoring Mode

	Monitor P-Bits	Correct P-Bits
VMR mode	Yes	Yes
VM mode	Yes	No
CC mode	No	No

If provisioned in the VMR or VM modes (Table 11-33), DS3 P-bit violations and SEFS are counted and the count is thresholded to flag detected performance degradation of the DS3 signal incoming from the fiber.

- Enhanced DS3 Performance Monitoring (see Table 11-41)
  - CV-P Coding Violations

    These errors are counted and thresholded independently for all DS3 interfaces provisioned in VM or VMR mode. When the F&M bit or C-bit option (C-bit is Release 5.0 and later releases) is selected, NEs could be provisioned in VMR or VM mode. See Table 11-34.
  - Errored Seconds (ES-P)
  - Severely Errored Seconds (SES-P)
  - Unavailable Seconds (UAS-P)
  - Severely Errored Frame Seconds (SEFS)
  - CV-L Line Coding Violations (Release 5.0 and later)
  - ES-L Errored Seconds LIne (Release 5.0 and later)
  - SES-L Severely Errored Seconds LIne (Release 5.0 and later)

Table 11-34. Enhanced DS3 Performance Monitoring Modes

Mode	PM Option	Monitor P-Bits	Monitor F&M Bits	Monitor C-Bits	Correct P-Bits	Correct F&M Bits	Correct C-Bits	Monitor Line PM
VMR	P-bit	Yes	No	No	Yes	No	No	Yes
VMR	F&M-bit	No	Yes	No	Yes	No	No	Yes
VMR	C-bit	No	No	Yes	Yes	No	No	Yes
VM	P-bit	Yes	No	No	No	No	No	Yes
VM	F&M-bit	No	Yes	No	No	No	No	Yes
VM	C-bit	No	No	Yes	No	No	No	Yes
CC	P-bit	No	No	No	No	No	No	Yes
CC	F&M-bit	No	No	No	No	No	No	Yes
CC	C-bit	No	No	No	No	No	No	Yes

BBG12 Triple EC-1 Low-Speed (3STS1E)

- Electrical Specification

  The EC-1 low-speed interface transmits and receives a standard electrical EC-1 signal as specified in *ANSI* T1.102-1993 (51.844 Mb/s rate, STSX-1 interconnect specification, bipolar 3-zero substitution [B3ZS] encoded and scrambled).

  Line buildout is provisionable as follows:

  — 734A/D: 0 to 450 ft.

  — 735A: 0 to 250 ft.

- Format Specification

  The EC-1 low-speed interface provides clear channel transport of any STS-1 signal compatible with the electrical STS-1 interface specifications in *ANSI* T1.102.

- Alarm Thresholding

  The following parameters are monitored at the EC-1 interface to the STSX-1:

  — Loss of signal (LOS)

  — Loss of frame (LOF)

  — Loss of pointer (LOP)

  — Line AIS

  — B2 thresholding signal fail

  — B2 thresholding signal degrade.

  The alarm level for each of the monitored parameters can be provisioned for CR, MJ, MN, or status. B2 signal degrade thresholds are user settable in the range from 10^{-6} to 10^{-9} BER.

- Performance Monitoring (see Table 11-41)

  — EC-1 line performance monitoring.

Optical Interfaces

The DDM-2000 OC-12 Multiplexer supports OC-12 long-reach applications at 1310 nm using the 23G/23G-U OLIU and at 1550 nm applications using the 23H/23H-U OLIU. The DDM-2000 OC-12 Multiplexer also supports OC-3 optical extensions using the 21G/21G-U and 21D/21D-U (IS-3) OLIUs. The 21G/21G-U OLIU is fully SONET compliant. The 21D/21D-U OLIU is a low cost IS-3 low-speed interface used primarily to interconnect the DDM-2000 OC-3 Multiplexer to the DDM-2000 OC-12 Multiplexer at the same site. The nominal OC-3 and IS-3 line rates are 155.520 Mb/s.

Lightguide Jumpers

The DDM-2000 OC-3 and OC-12 Multiplexers provide Lucent's universal optical connector on all OLIUs. The universal optical connectors are receptacles on the faceplate of the OLIUs that allow a single OLIU to support either *ST*, FC-PC, or SC connectors as needed. Both 0 dB and attenuating buildouts are supported.

To prevent potential degradations, the DDM-2000 OC-12 lightguide interface requires single-mode jumpers for connecting to and from the outside plant *LGX* panel and the DDM-2000 OC-12 for all OLIUs, except the 21D/21D-U OLIU.

The 21D/21D-U OLIU, used for intershelf OC-3/OC-12 interconnection, must use multimode jumpers on the transmit and receive sides.

Lightguide jumpers can be ordered from Lucent. See the "OC-12 Ordering — Miscellaneous Equipment and Tools" section for ordering information.

Long Reach OC-3 Interface (21G/21G-U/21G2-U/ 21G3-U OLIU)

- Optical Specification

  The 21G/21G-U/21G2-U/21G3-U OLIU photonics meet or exceed SONET long reach specifications (TR 253-LR-1 MLM category). The multilongitudinal mode (MLM*) laser transmitter supplies a non-return-to-zero (NRZ) coded signal. The positive intrinsic negative field effect transistor (PINFET) receiver allows direct optical loopback without the use of an external attenuator when the TRANSMIT POWER switch is on the low setting.

  The 21G/21G-U/21G2-U/21G3-U OLIU long reach OC-3 interface supports span lengths up to 55 km, assuming 0.45 dB/km single-mode fiber (including splices) and the span engineering rules outlined in Table 11-36. Transmit and receive powers are referenced to Points S and R as shown in Figure 11-2. Table 11-35, Table 11-36, and Table 11-37 provide detailed specifications and link budget information for the 21G/21G-U/21G2-U/ 21G3-U OLIU.

- Alarm Thresholding

  The following parameters are monitored at the OC-3 interface:

  — LOS

  — LOF

  — LOP

  — Line AIS

  — B2 thresholding signal fail

  — B2 thresholding signal degrade. (B2 signal degrade thresholds are user settable in the range from 10^{-5} to 10^{-9} BER.)

- PM (see Table 11-40)

  — Section severely errored frame seconds (SEFS)

  — Line parameter B2

  — Laser bias current (21G/21G-U only)

  — Transmit power (21G/21G-U only)

  — Receive power.

* A higher quality SLM laser may be used instead of a MLM laser.

IS-3 Interface (21D/21D-U OLIU)

- Optical Specification

  The 21D/21D-U OLIU is a short-reach optical interface used to interconnect between the DDM-2000 OC-3 and OC-12 Multiplexers. The nominal line rate is 155.520 Mb/s. The LED transmitter supplies an NRZ-coded signal.

  Table 11-35, Table 11-36, and Table 11-37 provide detailed specifications and link budget information for the 21D/21D-U OLIU.

- Alarm Thresholding

  The following parameters are monitored at the OC-3 interface.

  — Loss of signal (LOS)

  — Loss of frame (LOF)

  — Loss of pointer (LOP)

  — Line AIS

  — B2 thresholding signal fail

  — B2 thresholding signal degrade.

  B2 signal degrade thresholds are user settable in the range from 10^{-5} to 10^{-9} BER.

- Performance Monitoring (seeTable 11-41)

  — Section SEFS

  — B2 parameters.

Table 11-35 lists the 21G/21G-U/21G2-U/21G3-U and 21D/21D-U OLIU specifications.

Table 11-35. 21G/21G-U/21G2-U/21G3-U and 21D/21D-U OLIU Specifications

System Information:		
Terminal Equipment Identification	21G/21G-U/21G2-U/ 21G3-U OLIU	21D/21D-UOLIU
Optical Line Rate (Mb/s)	155.520 Mb/s	155.520 Mb/s
Optical Line Coding	Scrambled NRZ	Scrambled NRZ
Optical Wavelength	1310 nm	1310 nm
Performance	SONET LR-1 (Long Reach)	Not applicable
Transmitter Information:		
Optical Device Temperature Controller	TEC(21G2-U/21G3-U no TEC)	No TEC
FDA Classification	Class I	Class I
Optical Source	InGaAsP Laser, MLM* Structure	LED
Faceplate Optical Connector	Lucent *ST*® C3000-A-2 (21G) UOC buildout assembly† (21G-U/21G2-U/21G3-U‡) Single Mode	Lucent *ST* C2000-A-2(21D) UOC buildout assembly† (21D-U) Multimode
Receiver Information:		
Optical Device Temperature Controller	None	None
Optical Detector	InGaAsP PIN	InGaAsP PIN
Faceplate Optical Connector	Lucent *ST* C2000-A-2 (21G) UOC buildout assembly† (21G-U/21G2-U/21G3-U‡) Multimode	Lucent *ST* C2000-A-2 (21D) UOC buildout assembly† (21D-U) Multimode

* A higher quality SLM laser may be used instead of the MLM.

† The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either *ST*, SC, or FC-type connectors.

‡ The 21G3-U ships with two (2) 0 dB SC line buildouts installed and includes two (2) *ST* 0 dB buildouts shipped loose with the unit.

Table 11-36. 21G/21G-U/21G2-U/21G3-U and 21D/21D-U OLIU Link Budgets (Note 1)

Parameter	21G2-U 21G3-U†††	21G/21G-U Tx High (Note 2)	21G/21G-U Tx Low	21D/21D-U
Minimum Wavelength (λ_{Tmin})	1280 nm	1282/1280* nm	1282/1280* nm	1270/1260* nm
Maximum Wavelength (λ_{Tmax})	1335 nm	1325/1335* nm	1325/1335* nm	1380 nm
Spectral Width ($\delta\lambda_{rms}$)	4.0 nm *** 1.0 nm (21G3-U)	4.0 nm	4.0 nm	170 nm FWHM ¶¶
Maximum Transmitter Power† (P_{Tmax})	0.0 dBm	–2.5 dBm	–7.5 dBm	–14.0 dBm
Minimum Transmitter Power (P_{Tmin})	–5.0 dBm	–5.0 dBm	–11.4 dBm	–18.8/–21.8 dBm
Maximum Received Power (P_{Rmax})	0.0 dBm	–7.0 dBm	–7.0 dBm	–14.0 dBm
Minimum Received Power (P_{Rmin})	–34.0 dBm	–34.0 dBm	–34.0 dBm	–33.8/–31.8* dBm
Minimum System Gain (S-R)‡	29.0 dB	29.0 dB	22.6 dB	15/10.0* dB
Optical Path Penalty (P_O)§	1.0 dB	1.0 dB	1.0 dB	1.6 dB
Connector Loss¶	1.5 dB	1.5 dB	1.5 dB	1.5 dB
Unallocated Margin**	1.5 dB	1.5 dB	1.5 dB	2.0 dB
Minimum Loss Budget	0.0 dBm	4.5 dB††	0.0 dB	0.0 dB
Maximum Loss Budget‡‡	**25.0 dB**	**25.0 dB**	**18.6 dB**	**9.9/4.9* dB**
Maximum Span Length§§	55 km	55 km	41 km	(Note 3)

Notes:

1. All terminology is consistent with TR-253, Iss. 2. All specifications for 21G/21G-U OLIU meets or exceeds long reach (LR) values described in TR-253, Iss. 2.
2. The High/Low transmitted power switch on the 21G/21G-U OLIU circuit pack allows for loopbacks or small outside plant (OSP) budgets without external attenuators.
3. Multimode only. See Table 11-37.

* When two numbers are given, the number before the slash is the specification for operating under controlled environmental conditions. The number following the slash is the specification for uncontrolled environmental conditions. If only one number is given, it applies to both controlled and uncontrolled environmental conditions.

† Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

‡ The minimum system gain for the DDM-2000 already takes into account aging, temperature, and manufacturing tolerances as these figures are built into the minimum transmitter power. The DDM-2000 system gain can, thus, not be directly compared with the DDM-1000 system gain because the DDM-1000 system gain does not include all of these effects. A similar penalty, called eye margin, is subtracted from the DDM-1000 loss budget after the value of system gain is determined.

§ Optical path penalty includes effects of dispersion, reflection and jitter that occur on the optical path.

¶ One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.

** Unallocated margin, or safety margin, is typically specified from 0 dB to 3 dB.

†† If the loss budget is less than 6.0 dB, use low power. Includes a 1.5 dB safety margin.

‡‡ Budget available for both station and transmission cable and splices.

§§ Attenuation and dispersion can be the limiting factors in span length. For OC-3 single-mode fiber systems, dispersion is not a factor and all applications are attenuation limited. For OC-12 systems, the maximum distance could be either attenuation limited or dispersion limited. The limits must be calculated based on both factors and the lesser of the two defines the actual maximum span length. A rough rule of thumb for attenuation-limited systems is 0.45 dB/km. This estimate includes typical cable loss (0.4 dB/km) and splice loss (0.2 dB per splice, 11 total splices) associated with single-mode fiber.

Maximum span length can be calculated more precisely based on particular fiber and splice characteristics and local engineering rules.

¶¶ Full width at half maximum.

*** 1.0 nm for a SLM laser.

††† The 21G3-U OLIU will replace the 21G, 21G-U, and 21G2-U OLIUs.

Table 11-37. OC-3 OLIUs Link Budget — Multimode Operation

Fiber Bandwidth	Maximum Span Length (km) 21G/21G-U/21G2-U/21G3-U (Note 1)	21D/21D-U (Note 2)
1000 MHz-km	6.5	3.6/3.4
800 MHz-km	5.1	3.4/3.3
500 MHz-km	3.1	2.7
300 MHz-km	1.8	1.9

Notes:

1. Maximum 21G/21G-U/21G2-U/21G3-U MM Link Budget (dB) for multimode operation is 22.0 dB for high power and 15.6 dB for low power.
2. When two numbers are given, the number before the slash is the specification for operating under controlled environmental conditions. The number following the slash is the specification for uncontrolled environmental conditions. If only one number is given, it applies to both controlled and uncontrolled environmental conditions.

Multimode fiber operation on the DDM-2000 OC-3 Multiplexer requires a minimum exit bandwidth of 120 MHz to ensure that dispersion loss is kept below acceptable levels. If the fiber is already installed, and the exit bandwidth is measured to be 120 MHz or greater, then the maximum link budget values (22 dB, 15.6 dB, and 12 dB, respectively) can be used to determine if the loss budget is sufficient for that fiber.

The system is dispersion limited for all the fiber bandwidths listed in this table.

If planning a new fiber installation, the values at the end of the table, given for a number of commercially available fiber bandwidth-distance products, can be used. Fiber distances are calculated using the 120 MHz exit bandwidth limit, however, actual exit bandwidths may be higher for these distances due to the existence of splices. This may permit longer span lengths to be achieved, for the given fiber bandwidths, than those specified in the table. In this case, however, the span length can only be increased to the point where the system is loss-limited as specified by the maximum multimode link budget given in the table (1 dB/km cable is assumed).

Long Reach 1310 nm OC-12 Interface (23G/23G-U OLIU)

The DDM-2000 OC-12 Multiplexer supports a 1310 nm OC-12 high-speed interface that is fully SONET-compliant. The nominal OC-12 line rate is 622.08 Mb/s.

- Optical Specification

  The OLIU photonics meet or exceed SONET long reach specifications (TR-LR-1 MLM category). The multilongitudinal mode laser transmitter supplies an NRZ-coded signal. The receiver requires the use of an external attenuator for direct optical loopback.

  The 23G/23G-U OLIU long reach OC-12 interface supports span lengths up to 51 km, assuming 0.45 dB/km single-mode fiber (including splices) and the span engineering rules outlined in Table 11-39. Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

- Laser bias current is monitored on the 23G/23G-U OLIU.

Long Reach 1550 nm OC-12 Interface (23H/23H-U OLIU)

The DDM-2000 OC-12 Multiplexer supports a 1550 nm OC-12 long reach high-speed interface for controlled environments. The nominal OC-12 line rate is 622.08 Mb/s.

- Optical Specification

  The single longitudinal mode laser transmitter supplies an NRZ-coded signal. The receiver requires the use of an external attenuator for direct optical loopback.

  The 23H/23H-U OLIU long reach OC-12 interface supports span lengths up to 100 km, assuming single-mode fiber with total dispersion of less than 1800 ps/nm and the span engineering rules outlined in Table 11-39. Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

Table 11-38 lists the 23G/23G-U and 23H/23H-U OLIU specifications.

Table 11-38. 23G/23G-U and 23H/23H-U OLIU Specifications

System Information:		
Terminal Equipment Identification	23G/23G-U OLIU	23H/23H-U OLIU
Optical Line Rate (Mb/s)	622.080 Mb/s	622.08 Mb/s
Optical Line Coding	Scrambled NRZ	Scrambled NRZ
Optical Wavelength	1310 nm	1550 nm
Performance	SONET LR-1 MLM (Long Reach)	Not Applicable
Transmitter Information:		
Optical Device Temperature Controller	TEC	TEC
FDA Classification	Class I	Class I
Optical Source	InGaAsP Laser, MLM Structure *	InGaAs Laser SLM Structure
Faceplate Optical Connector	Lucent Buildout Assembly †(23G) UOC Buildout Assembly ‡ (23G-U) Single Mode	Lucent Buildout Assembly (23H) † UOC Buildout Assembly ‡ (23H-U) Single Mode
Receiver Information:		
Optical Device Temperature Controller	None	None
Optical Detector	Ge APD/InGaAs PIN	InGaAs APD
Faceplate Optical Connector	*ST* C2000-A-2 (23G) UOC Buildout Assembly ‡ (23G-U) Multimode	Lucent *ST* C2000-A-2 (23H) UOC Buildout Assembly ‡ (23H-U) Single Mode

* A tighter specification DFB laser will be supplied in the Series 1:2 23G-U OLIU instead of the MLM laser. The DFB laser meets all of the requirements of the MLM laser and of the DFB requirements in GR-253-CORE, Issue 2, December 1995.

† Buildout assembly consists of A3001 *ST* lightguide buildout block assembly and one of the following: A3010 (0 dB), A3010B (5 dB), A3010D (10 dB), and A30310F (15 dB). For 23H loopback testing requiring 19 dB, use the 4C Test Cable.

‡ The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either *ST*, SC, or FC-type connectors. For 23H-U loopback testing requiring 10 dB, use A3060D1 SC, A3070D1 ST, or A3080D1 FC attenuators as applicable.

Table 11-39. 23G/23G-U and 23H/23H-U OLIU Link Budgets (Note 1)

Parameter	23G/23G-U (Note 2)	23H/23H-U (Note 3)
Minimum Wavelength (λ_{Tmin})	1298 nm	1530 nm
Maximum Wavelength (λ_{Tmax})	1325 nm	1570 nm
Spectral Width* ($\delta\lambda_{rms}$)	2.0 nm	<1.0 nm
Maximum Transmitter Power† (P_{Tmax})	+2.0 dBm	+2.0dBm
Minimum Transmitter Power (P_{Tmin})	–2.5/–3.0 dBm‡	–2.8 dBm
Maximum Received Power (P_{Rmax})	–8.0 dBm	–17.0 (23H) –8.0 (23H-U) dBm
Minimum Received Power (P_{Rmin})	–30.5/–27.5 dBm‡	–34.0 dBm
Minimum System Gain (S-R)§	28.0/24.5 dBm‡	31.2 dBm
Optical Path Penalty (P_O)¶	2.0 dB	1.0 dB
Connector Loss**	1.5 dB	1.5 dB
Unallocated Margin††	1.5 dB	1.5 dB
Minimum Loss Budget‡‡	10.0 dB	19.0 (23H) 10.0 (23H-U) dB
Maximum Loss Budget§§	23.0/19.5 dB‡	27.2 dB‡
Maximum Span Length¶¶	51/43 km	100 km

Notes:.

1. All terminology is consistent with TR-253, Iss. 2. All values are worst-case end of life.
2. All specifications for the 23G/23G-U meet or exceed long reach (LR) values described in TR-253, Iss. 2.
3. This loss budget applies to 1550 nm optical signals transmitted and received by the 23H/23H-U.

* RMS spectral width for the 23G/23G-U. Maximum –20 dB down spectral width for the 23H/23H-U.

† Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

‡ When two numbers are given, the number before the slash is the specification for operating under controlled environmental conditions. The number following the slash is the specification for uncontrolled environmental conditions. If only one number is given, it applies to both controlled and uncontrolled environmental conditions (23G/23G-U only). The 23H/23H-U operates under controlled environmental conditions only.

§ The minimum system gain for the DDM-2000 already takes into account aging, temperature, and manufacturing tolerances as these figures are built into the minimum transmitter power. The DDM-2000 system gain can, thus, not be directly compared with the DDM-1000 system gain because the DDM-1000 system gain does not include all of these effects. A similar penalty, called eye margin, is subtracted from the DDM-1000 loss budget after the value of system gain is determined.

¶ Optical path penalty includes effects of dispersion, reflection and jitter that occur on the optical path. The 23G/23G-U has 5.0 dB of total margin. Optical path penalty is normally 1.0 dB. This allows for a maximum dispersion of 92 psec/nm in the 1310 nm wavelength range. To allow for span lengths greater than 40 km, 2.0 dB is allocated for optical path penalty. This allows a maximum dispersion of 120 ps/nm. 1.0 dB is allocated for the optical path penalty for the 23H/23H-U for operation in the 1550 nm wavelength range. This allows a maximum dispersion of 1800 ps/nm.

** One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.

†† Unallocated margin, or safety margin, is typically specified from 0 dB to 3 dB.

‡‡ The 23G/23G-U requires an external lightguide buildout as part of the connector assembly for loopbacks and for loss budgets less than 10 dB. The 23H/23H-U requires an external lightguide buildout as part of the connector assembly for loopbacks and for loss budgets less than 19 (23H) or 10 (23H-U) dB.

§§ Budget available for both station and transmission cable and splices.

¶¶ Attenuation and dispersion can be the limiting factors in span length. For OC-12 systems, the maximum distance could be either attenuation limited or dispersion limited. The limits must be calculated based on both factors and the lesser of the two defines the actual maximum span length. A rough rule of thumb for attenuation-limited systems operating in the 1310 nm wavelength range is 0.45 dB/km. This estimate includes typical cable loss (0.4 dB/km) and splice loss (0.2 dB per splice, 11 total splices) associated with single-mode fiber in the 1310 nm range. A rough rule of thumb for systems operating in the 1550 nm wavelength range on modern nondispersion shifted fiber is 0.25 dB/Km.

Allowing 2.0 dB for the optical path penalty implies 120 ps/nm total dispersion in the 1310 nm wavelength range. Typical maximum slope for single-mode fiber in this wavelength is 0.092 ps/nm squared per km. Typical nondispersion shifted fiber has a zero dispersion wavelength between 1300 and 1320 nm. Given these assumptions, the maximum span length for the 23G/23G-U is 51km.

For OC-12 systems operating in the 1550 nm wavelength range, the maximum distance is dispersion limited. Allowing 1 dB for the optical path penalty implies 1800 ps/nm total dispersion. Typical modern nondispersion shifted fiber has 18 ps/(nm•km) dispersion in the 1550 nm wavelength range. Given these assumptions, the maximum span length for the 23H/23H-U is 100 km.

Maximum span length can be calculated more precisely based on particular fiber and splice characteristics and local engineering rules.

OC-3 Optical Interface Mixing

See "OC-3 Optical Interface Mixing" in the DDM-2000 OC-3 Multiplexer part of this section.

Universal Optical Connector Attenuators

The DDM-2000 OC-3 and OC-12 Multiplexers provide Lucent's UOC on all OLIUs. The UOCs are receptacles on the faceplate of the OLIUs that allow a single OLIU to support either *ST*, FC-PC, or SC connectors as needed. Both 0 dB and attenuating buildouts are supported. See "Universal Optical Connector Attenuators" in the DDM-2000 OC-3 Multiplexer part of this section.

SONET Overhead Bytes

The only use of SONET overhead bytes for proprietary signaling is the K2 and S1 byte for synchronization messaging. See Section 6, "System Planning and Engineering," for more information on synchronization messaging.

Performance

Wander/Jitter

- The OC-12 interface accommodates at least 10 microseconds of wander per 24-hour period without buffer overflow or depletion.
- For SONET optical interfaces, the maximum time interval error (MTIE) does not exceed 60 nanoseconds phase variation when timed with a wander-free reference.
- Jitter transfer, tolerance, and generation requirements are met as specified in TR-253 and TR-499.
- The SONET interface meets the T1.101 OC-N output short term stability mask.

Signal Performance

- For systems interfacing at the DS3 rate, the number of errored seconds, during a 2-hour, one-way loopback test, is less than 72.
- The BER is less than 10^{-9} for DS3 rates. Burst error seconds are excluded.
- The frequency of burst errored seconds, other than those caused by protection switching induced by hard equipment failures, average less than 4 per day.

Synchronization

Synchronous Timing Generator (BBF2/BBF2B)

The TGS circuit pack meets the specifications of GR-253-CORE, SONET Transport Systems Generic Criteria. The TGS circuit pack supports three timing modes:

- External timing (phase-locked mode): Locked to external Stratum 3 (±4.6 ppm) or better DS1 reference.
- Line-timing: Locked to recovered clock from an OC-N signal.
- Free-running: Timing derived from high-stability temperature-compensated voltage-controlled crystal oscillator (TCVCXO) with a long-term accuracy of ±15 ppm (–40°C to +75°C).

Holdover mode is entered on failure of external timing or line-timing reference, providing a temperature stability of ±8.8 ppm (–40°C to +75°C). 24-hour holdover stability will be better than ±4.6 ppm.

The DS1 timing output used for network synchronization (BBF2B only) provides long-term accuracy traceable to the OC-12 line. SONET synchronization messaging is used to output DS1 AIS when clock traceability is lost (Release 2.0). Jitter on the DS1 output is less than 0.06 unit interval peak-to-peak.

Synchronous Timing Generator 3 (BBF4)

The TG3 Stratum 3 circuit pack meets the specifications of GR-253-CORE, SONET Transport Systems Generic Criteria. The TG3 circuit pack supports three timing modes:

- External timing: Locked to external Stratum 3 (±4.6 ppm) or better DS1 reference.
- Line-timing: Locked to recovered clock from an OC-N signal.
- Free-running: Timing derived from high-stability temperature-compensated voltage-controlled crystal oscillator (TCVCXO) with a long-term accuracy of ±4.6 ppm and temperature stability of ±2 ppm.

Holdover mode is entered on failure of external timing or line-timing reference, providing a temperature stability of ±2 ppm (–40°C to +75°C) or ± .3 ppm (0°C to +70°C). Holdover capability for 24 hours will be better than ±.37 ppm.

The DS1 timing output used for network synchronization (BBF2B or BBF4) provides long-term accuracy traceable to the OC-N signal.

Protection Switching

Linear Networks

Automatic line switches are initiated by signal fail and signal degrade conditions on the received OC-12 signals. This signal's BER is calculated from violations of the SONET line overhead B2 parity byte. Signal fail is declared for incoming LOS, LOF, line AIS or a BER exceeding 10^{-3}, while a BER exceeding a provisionable threshold between 10^{-5} and 10^{-9} causes a signal degrade to be declared. Line protection will be completed within 50 milliseconds of the onset of a signal fail, or a hard failure such as a fiber cut, and within 60 milliseconds of the declaration of a signal degrade condition. For a protection switch in response to an external command, the interrupt interval is less than 10 milliseconds.

Ring Networks

Path protection rings feed a SONET payload (STS or virtual tributary [VT]) from the ring entry point, simultaneously in both rotations of the ring, to the signal's ring exit point. The node that terminates the signal from the ring monitors both ring rotations and is responsible for selecting the signal that has the highest quality based on LOS, path AIS, and path BER performance. On pass-through paths, all detected hard failures (LOS, LOF, LOP, line AIS, STS path AIS, or STS unequipped) result in STS AIS insertion in the outgoing signals. This allows the terminating node to be aware of the failure and to switch to protection. Protection switching is completed within 50 milliseconds of failure detection.

Under normal conditions, both incoming SONET path signals to the switch selection point are of high quality, and the signal can be selected from either ring. A failure or a transmission degradation on one of the rings requires that the other ring path be selected. Release 3.1 provides nonrevertive switching to minimize the impact on critical customer services by giving the service provider control when, and if, the critical service should revert to a particular ring. A manual path protection switching command allows switching back to the original path for ease of ring maintenance.

The protection switching interrupt interval in response to an equipment failure is 60 milliseconds for all 1x1 protected circuit packs. The interrupt interval is measured at the DSn interface.

Transient Performance

Power Loss Restart

After system shutdown due to power loss, the system will exhibit a 2-second error free transmission interval which begins within 1 minute of restoration of power.

Transmission Start-Up on Signal Application

The system, after having no signal applied for greater than 1 minute at the DSX-n interface or at any nonhierarchical interface, will exhibit a 2-second error free transmission interval which begins within 5 seconds of the reapplication of a signal.

Delay

Table 11-40 lists the worst-case measured one-way delay within a DDM-2000 OC-12 Multiplexer and OC-12 Regenerator.

Table 11-40. OC-12 Multiplexer and OC-12 Regenerator Transmission Delay in Microseconds

	Drop Interface			
Mode	**OC-12**	**OC-3/OC-3c**	**DS3**	**EC-1**
Terminal		4	5	4
Ring	4	4	5	4
OC-12 Regenerator	2			

Performance Monitoring

Table 11-41 shows the provisionable range of the thresholds for monitored parameters and, in parentheses, the default thresholds. Thresholding of any parameter(s) can be disabled. PM parameters are provisionable via the CIT.

Table 11-41. Performance Monitoring Parameters Provisionable via the CIT

Parameter Definition		Threshold Range (Default)		Command
Facility	**Measure**	**Current Quarter Hour**	**Current Day**	**set-pmthres-**
OC-12 Optics	Laser Bias Current *	enable/disable	enable/disable	sect
OC-3 Optics	Optical Transmit Power *(21G/21G-U only) Laser Bias Current* (21G/21G-U only)	-1 dB, -2 dB enable/disable	-1 dB, -2 dB enable/disable	sect sect
OC-12 Section	SEFS	1-63 [10]	1-4095 [30]	sect
OC-3 Section	SEFS	1-63 [10]	1-4095 [30]	sect
OC-12 Line	B2 Coding Violations (CV) B2 Errored Seconds (ES) B2 Errored Seconds Type A (ESA) B2 Errored Seconds Type B (ESB) B2 Severely Errored Seconds (SES) B2 Unavailable Seconds (UAS) Line Protection Switch Counts (PSC-L) STS Pointer Justification Counts (PJC)	1-55365 [5537] 1-900 [40] 1-900 [30] 1-900 [30] 1-63 [20] 1-63 [30] 1-63 [2] 1-65535 [60]	1-5315040 [531504] 1-65535 [900] 1-65535 [90] 1-65535 [90] 1-4095 [60] 1-4095 [90] 1-255 [4] 1-9999999 [5760]	line line line line line line line line
OC-3 Line	B2 Coding Violations (CV) B2 Errored Seconds (ES) B2 Errored Seconds Type A (ESA) B2 Errored Seconds Type B (ESB) B2 Severely Errored Seconds (SES) B2 Unavailable Seconds (UAS) Line Protection Switch Counts (PSC-L) STS Pointer Justification Counts (PJC)	1-13841 [1384] 1-900 [40] 1-900 [30] 1-900 [30] 1-63 [20] 1-63 [30] 1-63 [2] 1-65535 [60]	1-1328736 [132874] 1-65535 [900] 1-65535 [90] 1-65535 [90] 1-4095 [60] 1-4095 [90] 1-255 [4] 1-9999999 [5760]	line line line line line line line line
EC-1 Line	B2 Coding Violations (CV) EC-1 B2 Errored Seconds (ES) B2 Errored Seconds Type A (ESA) B2 Errored Seconds Type B (ESB) B2 Severely Errored Seconds (SES) B2 Unavailable Seconds (UAS) STS Pointer Justification Counts (PJC)	1-4613 [461] 1-900 [40] 1-900 [30] 1-900 [30] 1-63 [20] 1-63 [30] 1-65535 [60]	1-442848 [44285] 1-65535 [900] 1-65535 [90] 1-65535 [90] 1-4095 [60] 1-4095 [90] 1-9999999 [5760]	line line line line line line line

Table 11-41. Performance Monitoring Parameters Provisionable via the CIT—*Continued*

Parameter Definition		Threshold Range (Default)		Command
Facility	**Measure**	**Current Quarter Hour**	**Current Day**	**set-pmthres-**
STS-1 Path	B3 Coding Violations (CV) B3 Errored Seconds (ES) B3 Errored Seconds Type A (ESA) B3 Errored Seconds Type B (ESB) B3 Severely Errored Seconds (SES) B3 Unavailable Seconds (UAS)	1-4510 [451] 1-900 [40] 1-900 [30] 1-900 [30] 1-63 [20] 1-63 [30]	1-432960 [43296] 1-65535 [900] 1-65535 [90] 1-65535 [90] 1-4095 [60] 1-4095 [90]	sts1 sts1 sts1 sts1 sts1 sts1
DS3 Path †	P-bit Error Counts SEFS	1-4026 [403] 1-63 [10]	1-386500 [38650] 1-4095 [30]	t3 t3
Enhanced DS3 Path for P-Bits, F&M Bits, and C-Bits from Fiber and DSX §	CV-P Coding Violations ES-P Errored Seconds SES-P Severely Errored Seconds UAS-P Unavailable Seconds SEFS	1-16383 [40] 1-900 [25] 1-63 [4] 1-63 [10] 1-63 [2]	1-1048575 [3820] 1-65535 [250] 1-4095 [40] 1-4095 [10] 1-4095 [8]	t3 t3 t3 t3 t3
DS3 Line ‡	CV-L Coding Violations Errored Seconds, Line (ES-L) Severely Errored Seconds, Line (SES-L)	1-16383 [40] 1-900 [25] 1-63 [4]	1-1048575 [3865] 1-65535 [250] 1-4095 [40]	t3 t3 t3

* Threshold is set once for both current quarter-hour and current day

† Prior to Release 3.1.

‡ Release 5.0 and later releases.

§ DS3 path from the fiber Release 3.1 and later releases; DS3 path from the fiber and DSX and C-Bit option are Release 5.0 and later releases.

Operations Interfaces

This section presents the operations interfaces that are required to support technician access to the system and allow alarms and status information generated by the system to be reported. The local operations interfaces include the CIT interface, the user panel, and the equipment indicators. DDM-2000 OC-12 Multiplexers support office alarms, parallel telemetry, user-definable miscellaneous discretes, serial (TBOS) telemetry interfaces, and TL1/X.25.

Craft Interface Terminal

The system provides two EIA-232-D compatible CIT interfaces—a front access interface, configured as a DCE, and a rear access CIT interface, configured as a DTE—to allow a permanent modem connection without requiring a null modem. A null modem is required to connect an ASCII terminal to the DTE interface or a modem to the DCE interface. The CIT interfaces provide data rates of 300, 1200, 2400, 4800, 9600, and 19,200 baud.

Both CIT interfaces operate full duplex using 1 start bit, 8 data bits, and 1 stop bit. Table 11-42 describes the pins supported on the CIT interfaces:

Table 11-42. CIT Interface Pin Connection

EIA-232-D Pin	Front Access CIT (DCE)	Rear Access CIT (DTE)
Pin 2—Circuit BA Transmitted Data	carries data from terminal to DDM-2000	carries data from DDM-2000 to modem or terminal
Pin 3—Circuit BB Received Data	carries data from DDM-2000 to terminal	carries data from modem or terminal to DDM-2000
Pin 7—Circuit AB Signal Ground	signal ground	signal ground
Pin 8—Circuit CF Received Line Signal Detector	not used	indicates to DDM-2000 that modem or terminal is connected
Pin 20—CIrcuit CD DTE Ready	indicates to DDM-2000 that modem or terminal is connected	indicates to modem or terminal that DDM-2000 is connected (always ON when SYSCTL is powered)

A CIT is recommended for installation, maintenance, and administrative activities. A PC is required for software download and to run CPro-2000 software. The DDM-2000 OC-12 Multiplexer CIT port (mounted on the user panel) is a standard EIA-232-D (supersedes RS-232C specification) interface configured as DCE for direct connection to a CIT. The CIT port will support rates of 300, 1200, 2400, 4800, 9600, and 19,200 baud and should be compatible with most *ANSI* 3.64 ASCII terminals; however, it is optimized for standard screens with display areas

of 24 lines by 72 (or more) columns. A pager function is included in the DDM-2000 OC-12 Multiplexer to accommodate screen lengths from 3 lines to 150 lines.

Those CITs compatible with DDM-1000 (see 363-206-100 for a list of DDM-1000 compatible terminals) should be directly compatible with the DDM-2000 OC-12 Multiplexer although some may not be as convenient to use with the DDM-2000 OC-12 Multiplexer.

If the multishelf bus cables (ED-8C724-20, G354 or G356) are connected between shelves in a bay, a CIT may then be connected to the user panel CIT port on any shelf and may address any other shelf in that bay (as well as the remote terminal shelves associated with that shelf in the bay). Any terminal compatible with the *ANSI* 3.64 standard should be compatible with the DDM-2000 OC-12 Multiplexer.

Personal Computer Specifications for Software Download

The PC used for software download software should have:

- A minimum of 640K of RAM
- *MS-DOS* version 2.0 or newer
- Hard disk
- At least one floppy disk drive of 360K or larger capacity. Although software download can be done from either floppy or hard disk, a hard disk is preferred for its better performance. The disk requirement is met with most portable *MS-DOS* PCs with a single 3.5-inch disk (720K or larger capacity). An *MS-DOS* PC with a hard disk and either a 3.5-inch 720K or 5.25-inch 360K (or larger) floppy disk may also be used.

Compatible Modems

A compatible modem must meet the following minimum requirements:

- 300, 1200, 2400, 4800, 9600, or 19,200 baud
- Full duplex
- 8 data bits
- No parity bits
- 1 start bit
- 1 stop bit
- No flow control.

The following stand-alone modems meet the modem requirements and can be used with the DDM-2000 system. *Western Electric* 103-compatible and 212A-compatible modems are also suitable for use with the DDM-2000 system. This is not an exhaustive list of compatible modems:

- *Paradyne*[*] 2224-CEO modem (at 1200 and 2400 baud)
- *Paradyne* 2224 modem (at 1200 and 2400 baud)
- *Paradyne* 4024 modem (at 1200 and 2400 baud)
- *Paradyne* 2296 modem (at 4800 and 9600 baud)
- Hayes *V-series*[†] Smartmodems
- *Penril*[‡] Alliance V.32 modem.

The *NCR* 3170 computer and the AT&T *Safari* computer have a built-in modem and meet the modem requirements.

* Trademark of AT&T.
† Trademark of Hayes Microcomputer Products, Inc.
‡ Registered trademark of Penril Corporation.

CPro-2000 Graphical User Interface and Provisioning Tool

The CPro-2000 Graphical User Interface and Provisioning Tool supports DDM-2000 OC-3 Multiplexers, DDM-2000 OC-12 Multiplexers, and FT-2000 OC-48 Lightwave Systems. See "CPro-2000 Graphical User Interface and Provisioning Tool" in the DDM-2000 OC-3 Multiplexer part of this section for technical specifications.

User Panel

The user panel contains red LEDs for CR and MJ alarms, yellow LEDs for MN and PMN alarms and for abnormal (ABN), far end activity (FE-ACTY), and near end activity (NE-ACTY) status. These LEDs are used in conjunction with the far end identification (FE-ID) 7-segment display on the front panel of the adjacent SYSCTL circuit pack to provide CIT-less single-ended operations.

A green PWR ON LED is lighted when the shelf is receiving –48V power. A green ACO LED is lighted when the alarm cutoff (ACO) function is active.

The FE SEL test, ACO/TEST, and UPD/INIT pushbuttons are provided to control system operation.

Equipment Indicators

A red LED FAULT indicator is provided on all circuit packs. A green LED ACTIVE indicator is provided on all 1x1 protected circuit packs to indicate which circuit packs are actively carrying traffic.

Office Alarms

The office alarms interface is a set of discrete relays that control office audible and visual alarms. Separate relays handle CR, MJ, and MN alarms. Each contact closure is rated at 1 A, 60 V, maximum. The CR and MJ alarms can be wire-ORed. The CR alarm relays are fail-safe against unprotected power failures.

Serial Telemetry

Serial telemetry is provided using the TBOS protocol. TBOS telemetry provides detailed AS&C information.

- A 2400 baud RS-422 port is needed
- A TBOS link can support up to eight displays
- A TBOS display is required for each DDM-2000 OC-12 Multiplexer.

Parallel Telemetry

Parallel telemetry brings a minimum set of alarm and status information to an operations center. Four alarm closures indicate CR, MJ, MN, and PMN alarms.

The following status closures identify alarms as far-end or near-end, as failures on received OC-12 signals or incoming low-speed interfaces, and provide system identification when alarms are paralleled among several shelves in a bay.

- Near-end (NE) status
- Far-end (FE) status (six closures)
- Carrier line failure (CLF) status
- Incoming (INC) status
- System identification (SID) status
- ACO output (ACOO).

The parallel telemetry outputs tolerate –60 V maximum open circuit voltage and 35 mA maximum current. Transient voltages up to –135 V are tolerated for up to 1 ms. The parallel telemetry ACO input provides –48 V nominal (–60 V maximum) open circuit voltage and 2 mA maximum current.

The parallel telemetry output closures generated by the optoisolator require external voltage and ground to operate.

User-Definable Miscellaneous Discretes (Environmental Alarms and Controls)

The user-definable miscellaneous discrete environmental alarm and control interface allows the DDM-2000 OC-12 Multiplexers to monitor and control co-located equipment at the remote site. At the RT site, 21 alarm or status environmental inputs can monitor environmental conditions (for example, open door, high temperature); these inputs are activated by contact closures. The fifteenth environmental alarm or status input is provided to monitor the condition of the power shelf and fans at the RT site; this closure is activated by –48 V DC. Prior to Release 5.0, only 15 discretes were available. Four environmental control outputs are provided to control external equipment (for example, pumps or generators). The miscellaneous discrete outputs (control outputs at an RT, alarm/status outputs at a CO) tolerate –60 V maximum open circuit voltage and 35 mA maximum current. Transient voltages up to –135 V are tolerated for up to 1 ms. The miscellaneous discrete inputs (control inputs at a CO, alarm/status inputs an RT) provide –48 V nominal (–60 V maximum) open circuit voltage and 2 mA maximum current. The miscellaneous discrete output closures generated by the optoisolator require external voltage and ground to operate.

The 21 alarm or status inputs can be reported through a TL1/X.25 interface. The first 10 of these can also be reported through discrete telemetry outputs at the CO end. The first 15 of these inputs can also be reported through TBOS scan points.

Order Wire

The DDM-2000 OC-12 Multiplexer uses the E1 byte in the SONET overhead and provides a 64 Kb/s CMOS or TTL compatible interface to an external order wire shelf. This interface can be used with an external order wire shelf to provide point-to-point voice communication between DDM-2000 OC-12 systems via the SONET overhead channel.

The DDM-2000 OC-12 Multiplexer has been tested with the *DANTEL* Order Wire Assembly A18-04588-02.

See the "OC-12 Ordering — Miscellaneous Equipment and Tools" section for ordering information.

TL1/X.25 Interface

The DDM-2000 OC-12 Multiplexer supports a TL1/X.25 interface for communication between local and remote DDM-2000 Multiplexers and alarm surveillance and provisioning OSs, such as Telcordia Technologies' NMA and OPS/INE OSs. The DDM-2000 OC-12 Multiplexer TL1/X.25 interface is based on Telcordia Technologies TR-TSY-000833, Issue 5. The DDM-2000 OC-12 Multiplexer supports the X.25 permanent virtual circuits (PVCs) and switched virtual circuits (SVC) assigned as shown in Table 11-43.

Table 11-43. TL1/X.25 Interface — VC Assignments

PVC ID	SVC ID	Logical Group #	Logical Channel #	Use
1		0	1	Command/Response Messages and (User Definable §)
2		0	2	Autonomous Maintenance Messages, and Command/Response∗ Messages, and (User Definable §)
3 †		0	3	Autonomous Provisioning Messages (REPT DBCHG), Command/Response Messages, and (User Definable §)
	1 ‡	0	16	Autonomous Maintenance and Provisioning Messages, Command/Response Messages, and (User Definable §)
	2 §	0	17	User Definable §
	3 §	0	18	User Definable §
	4 §	0	19	User Definable §
	5 §	0	20	User Definable §
	6 §	0	21	User Definable §

∗ Release 2.0 and later.

† Release 2.1 (linear), 3.1 (rings), and later.

‡ Release 2.2 (linear), 3.1 (rings), and later.

§ Release 5.0 (rings) and later.

¶ Default values.

In Release 5.0 and later, DDM-2000 OC-12 supports the following OS types: tl1Maintenance, tl1MemoryAdministration, tl1Test, tl1PeerComm, tl1Other1, tl1Other2, and tl1CR. Any TL1 autonomous message can be mapped to any OS type (except tl1CR, which is command/response only). Also, in Release 5.0, DDM-2000 OC-12 supports nine VCs and any of these VCs can be active at a given time. In addition, any of the OS types can be mapped to any of the nine VCs.

At the packet layer, DDM-2000 OC-12 Multiplexers are configured as a passive DTE with the following parameters as shown in Table 11-44.

Table 11-44. TL1/X.25 Interface — X.25 Packet Layer Parameters

Parameter	Value
Packet Size	128 bytes * or 256 bytes
Window Size	2 packets
D bit support	NO
M bit support	YES

* Release 5.0 (rings) and later.

At the link layer, the DDM-2000 OC-12 Multiplexer uses the standard LAPB protocol with the following parameters as shown in Table 11-45.

Table 11-45. TL1/X.25 Interface — LAPB Link Layer Parameters

Parameter	Value
Maximum Frame Size	2104 bits
Modulo	8
Window Size	7 frames
n2	7 retires
T1	3 seconds
T3*	20 seconds

* DDM-2000 OC-12 Multiplexer Release 2.0 and later.

DDM-2000 OC-12 Multiplexers use synchronous, full duplex, and continuous carrier communication. Data rates of 1200, 2400, 4800, 9600, and 19,200 are supported. The EIA-232-D interfaces is configured as DTE, using the pin connections specified in Table 11-46.

Table 11-46. TL1/X.25 Interface - EIA-232-D Pin Connections

Pin	Description
2	Transmitted Data
3	Received Data
4	Request to Send
5	Clear to Send
6	DCE Ready
7	Signal Ground
8	Received Line Signal Detector
15	Transmitted Signal Element Timing (DCE to DTE)
17	Receiver Signal Element Timing (DCE to DTE
20	DTE Ready*

* DTE is always on when system is powered.

Physical Specifications

OC-12 Shelf Physical Characteristics

- Dimensions: 14 in. H x 21.25 in. W x 12 in. D (Group 1)
  Dimensions: 14 in. H x 21.25 in. W x 13.25 in. D (Group 4)
- Weight (Max.): 83 lb. (38 kg)
- Appearance: Coordinated with other equipment in the Lucent 2000 Product Family.

Fan Shelf Physical Characteristics

- Dimensions: 4 in. H x 21.25 in. W x 9 in. D
- Weight (Max.): 20 lb. (9 kg)
- Appearance: Coordinated with other equipment in the Lucent 2000 Product Family.

Network Bay and Cabinet Mounting

DDM-2000 OC-12 Multiplexers can be mounted in ED-8C500, ED-8C501 and ED-8C800, ED-8C801 (seismic) network bay frames. A maximum of three DDM-2000 OC-12 shelves may be mounted in a 7-foot bay. One OC-12 shelf and four OC-3 shelves can be mounted in a 7 foot bay. In addition to bay mounting, DDM-2000 OC-12 can be packaged with other equipment in 80A, 80D, and 80E cabinets, controlled environment vaults (CEVs), or huts.

NOTE:
The mounting brackets on the DDM-2000 OC-3, OC-12, heat baffle, and fan shelf are designed to allow for mounting in standard 23-inch wide network bay frames and 23-inch wide EIA-type bay frames.

Environmental Specifications

Temperature and Humidity

A DDM-2000 OC-12 Multiplexer meets Telcordia Technologies Network Equipment Building System (NEBS*) requirements. A DDM-2000 fan shelf is required in central office environments above every DDM-2000 OC-12 Multiplexer. Refer to ED-8C724-10 and ED-8C727-10, "Typical Bay Arrangements" for detailed information on placement of fans and heat baffles in typical bay arrangements.

The DDM-2000 OC-12 Multiplexer operates in uncontrolled environments at temperatures of –40°C to +75°C and humidity of 5 to 95 percent (noncondensing). Forced convection cooling (fans) is required in all applications. A DDM-2000 OC-12 Multiplexer provides alarming of the 2-type fan units used in Lucent cabinets and alarming of the DDM-2000 fan shelf in controlled environments.

1550 nm Systems

A DDM-2000 OC-12 Multiplexer shelf equipped for 1550 nm applications, using the 23H/23H-U OLIU, must operate in controlled environments at temperatures of 0°C to +49°C and humidity of 5 to 95 percent (noncondensing).

EMC Requirements

The DDM-2000 OC-12 Multiplexer has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio-frequency energy, and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residence is likely to cause harmful interference in which case the user will be required to correct the interference at the user's own expense. The DDM-2000 OC-12 Multiplexer has been tested and fully meets all Telcordia Technologies EMC requirements of TR-NWT-001089, Issue 1.

* "NEBS Generic Equipment Requirements," TR-NWT-000063, Issue 4.

Earthquake Requirements

The DDM-2000 OC-12 Multiplexer meets the earthquake requirements defined in Telcordia Technologies TR-NWT-000063, Issue 4, and Pacific Bell Standard PBS-000-102PT. Installation in Zone 4 regions requires the ED-8C800-50 or ED-8C801-50 bay frame. Drawing ED-8C800-70 provides ordering and engineering application information for these frames.

Fire Resistance

The DDM-2000 OC-12 Multiplexer meets the ignitability requirements specified in ANSI T1.307-1997. In addition, the DDM-2000 OC-12 Multiplexer meets the fire resistance requirements of *UL* 1459, 2nd Edition.

Underwriters Laboratories

The DDM-2000 OC-12 Multiplexer is *UL* listed for restricted access installations in business and customer premises applications installed in accordance with Articles 110-16 and 110-17 of the *National Electric Code*, *ANSI*/NFPA Number 70-87. Other installations exempt from the requirements of the *National Electric Code* may be engineered according to the accepted practices of the local telecommunications utility.

Canadian Standards Association

The DDM-2000 OC-12 Multiplexer has been certified by the Canadian Standards Association per standard C22.2 Number 225-M90.

Power Requirements

Shelf Fuses

The two –48 V feeders (A and B) are required for each DDM-2000 OC-12 shelf. Shelf power is protected by 10-amp fuses provided with the shelf. It is recommended that a supply of spare fuses be provided at DDM-2000 OC-12 Multiplexer locations.

Fuses and a fuse extraction tool can be ordered through Lucent, using Comcode 406203190 for fuses and Comcode 406420273 for the extraction tool, or through SAN-O Industrial Corporation, 91-3 Colin Drive, Sherwood Corporation Center, Holbrook, NY 11741 or by calling 516-472-6666 and ordering:

Fuse, 10-amp, Part No. AX-1-10A or
Fuse Extraction Tool, Part No. F-0431.

Power Dissipation

The power dissipation figures in Table 11-47 represent **fully loaded** shelves.

- DDM-2000 OC-12 shelf accommodates two –48 V power feeders ("A" and "B" office power feeders).
- Table 11-47 lists the List 1 and List 2 power drain.

Table 11-47. Power Dissipation and Current Drains

Configuration	Power Dissipation (Watts)	DC Current Drains (Amps)	
		L1 (–48V)	**L2** (–40V)
Pt-Pt DS3 Terminal * (12 DS3)	177	3.7	4.4
21G/21G-U Optical Hub * (4 OC-3)	201	4.2	5.0
21D/21D-U Optical Hub * (4 OC-3)	193	4.0	4.8
OC-12 Regenerator (4 REGENR circuit packs)	60	1.3	1.5
Pt-Pt EC-1 Terminal * (12 EC-1)	177	3.7	4.4
Ring Shelf * (12 EC-1)	187	3.9	4.7
Ring Shelf * (12 DS3)	187	3.9	4.7
Ring Shelf * E/W 21G/21G-U OLIU (4 OC-3)	211	4.4	5.3
DDM-2000 Fan Shelf	53	1.1	1.3

* These configurations require the DDM-2000 Fan Shelf. Fan power dissipation is listed separately.

The following items should be noted:

- Loss of one power feeder does not cause a loss of service.
- All supply voltages other than –48 V required by the DDM-2000 OC-12 Multiplexer are generated by DC-to-DC converters within the DDM-2000 OC-12 shelf.
- The DDM-2000 OC-12 Multiplexer meets all performance requirements when the DC input voltage varies between –40.0 V and –60.0 V.
- The DDM-2000 OC-12 Multiplexer tolerates DC input voltages between 0 V and –60 V without damage.
- The DDM-2000 OC-12 Multiplexer complies with electrical noise tolerance requirements in Section 13.2 of TR-TSY-000499.

CAUTION:
This information is for a typical application only. Consult 801-525-168, DDM-2000 Floor Plan Data Sheets and T-82046-30, Power Systems DC Distribution Circuit for Digital Transmission System for proper engineering of battery plant and feeders.

DDM-2000 OC-12 Reliability

Summary

This section describes the Telcordia Technologies reliability requirements that apply to the DDM-2000 OC-12 Multiplexer and the calculations used to predict how the DDM-2000 OC-12 Multiplexer meets those standards.

The DDM-2000 OC-12 Multiplexer meets all the applicable Telcordia Technologies reliability requirements that cover transmission availability, OS availability, silent failures, optical module maintenance, and infant mortality. Table 11-48 summarizes the reliability predictions and requirements. The applicable Telcordia Technologies requirements and objective were clarified through interactions with Telcordia Technologies during their audit of the DDM-2000 OC-12 Multiplexer. The basis for these requirements comes from TA-TSY-000418, "Generic Reliability Assurance Requirements for Fiber Optic Transport Systems." The method and assumptions used to calculate the DDM-2000 OC-12 Multiplexer reliability predictions are described in the following sections. Each section is devoted to one of the reliability parameters which must meet a Telcordia Technologies requirement or objective.

Transmission Availability

Telcordia Technologies *requirements* state that the probability of a hardware-caused outage on a two-way channel within a SONET multiplexer should be less than 1.75 minutes per year in a central office environment[*] and 5.25 minutes per year in a remote terminal environment.[†] Telcordia Technologies *objectives* for outages are 0.25 minutes per year for the central office[‡] and 0.75 minutes per year for remote terminal environments.[§]

The outage requirements and objectives apply to any part of the product needed to process an incoming high-speed or low-speed signal (DS3 to OC-12 or OC-12 to DS3). An outage is defined, for this and all other outage requirements, as any 1-second interval with a bit error rate of 10^{-3} or worse.[¶] The predicted hardware outages for various configurations of the DDM-2000 OC-12 system are given in Table 11-48.

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* TA-NWT-000418, Issue 3, November 1991, p. 17.

† TA-NWT-000418, Issue 3, November 1991, p. 28.

‡ TA-NWT-000418, Issue 3, November 1991, p. 18.

§ TA-NWT-000418, Issue 3, November 1991, p. 28.

¶ TR-TSY-000009, Issue 1, May 1986, p. 4-11.

A Markov model was used to calculate the predicted system outage. The model assumes a mean time to repair of 2 hours for the CO environment and 4 hours for the RT environment. Individual circuit pack failure rates used in the model were calculated using the method described in TR-TSY-000332, Issue 4, "*Reliability Prediction Procedure for Electronic Equipment (RPP)*." A summary of the circuit pack and fan shelf failure rates is shown in Table 11-49 and Table 11-50, respectively.

Operation System Interface Availability

The Telcordia Technologies objective states that the OS outage should be less than 28 minutes per year (50 percent hardware, 50 percent software). [*] Therefore, the objective applies to the TBOS and TL1/X.25 interfaces. This objective applies to circuitry needed to maintain communication from the DDM-2000 OC-12 Multiplexer to the central office's telemetry equipment for access by an OS. Since the OS interface is used in the central office, the reliability model assumes the mean time to repair is 2 hours and the environmental factor is 1.0. Table 11-48 lists the predicted outages for the TBOS and TL1/X.25 interfaces.

Optical Module Maintenance Objective

According to Telcordia Technologies, the objective for mean time between failure (MTBF) of a one-way regenerator is a minimum of 4 years. A regenerator is defined as any circuit packs that perform the electrical-to-optical and optical-to-electrical conversion. The failure rate of the 23G/23G-U OLIU is 11400 FITS according to the RPP method. This translates to a MTBF of 10 years, which meets the objective.

Infant Mortality

Telcordia Technologies requires that the number of circuit pack failures in the first year of operation should not exceed 2.5 times the number of failures per year beyond the first year. The ratio of first year failures to failures in subsequent years is known as the infant mortality factor (IMF). The requirement is to have an IMF of less than 2.5. [†]

DDM-2000 OC-3 Multiplexer circuit packs are subjected to an environmental stress testing (EST) program. The purpose of the program is to eliminate early life failures, conduct failure mode analysis on defective circuit packs, and use corrective action to make the product more reliable. All new circuit pack codes in manufacturing are subjected to EST. However, based on field return data, when

* TA-NWT-000418, Issue 3, November 1991, p. 36.

† TA-NWT-000418, Issue 3, November 1991, p. 40.

the early life failures for any circuit pack codes have been minimal and the infant mortality factor is below 2.5, these circuit pack codes may be subjected only to sampling EST.

DDM-2000 OC-12 System Reliability Predictions

Table 11-48. DDM-2000 OC-12 System Reliability Prediction (Note 1)

Application	Environment (Note 2)	Telcordia Criteria (Note 3)		Prediction (Outage, min/yr)	MTBF Years (Note 4)
		Requirement	Objective		
DS3 to OC-12	CO	1.75	0.25	0.0229	5218
DS3 to OC-12	RT	5.25	0.75	0.070	3397
EC-1 to OC-12	CO	1.75	0.25	0.0229	5223
EC-1 to OC-12	RT	5.25	0.75	0.0699	3402
OC-3 to OC-12 (21D-U)	CO	1.75	0.25	0.00020	448348
OC-3 to OC-12 (21D-U)	RT	5.25	0.75	0.00181	99644
OC-3 to OC-12 (21G2-U)	CO	1.75	0.25	0.00027	331891
OC-3 to OC-12 (21G2-U)	RT	5.25	0.75	0.00244	73763
OC-12 to OC-12	CO			7.80	15.4
OC-12 to OC-12	RT			23.41	10.2
OS Interface TBOS	CO		14.0	9.24	13.0
OS Interface TL1/X.25	CO		14.0	9.24	13.0

Example:
The unavailability of one two-way DS3 channel within one DDM-2000 OC-12 system configured to multiplex DS3 to OC-12, located in an uncontrolled environment, is 0.070 minutes per year (that is, fraction of time per year when the DS3 channel is unavailable). The mean time between outage of the DS3 channel is 3397 years (that is, average length of time until a DS3 outage occurs).

Notes:

1. Hardware failure rates are calculated per the RPP method, TR-NWT-000332, Issue 6, "Reliability Prediction Procedure."
2. The environmental factor for the CO = 1.0 and for the RT = 1.5, per TR-NWT-000332, Issue 4, "Reliability Prediction Procedure."
3. Telcordia Technologies criteria (Outage Requirements and Objectives) is based on TA-TSY-000418, Issue 3, "Generic Reliability Assurance Requirements for Fiber Optic Transport Systems." Outage is in minutes per year.
4. Mean time to repair is assumed to be 2 hours for the CO and 4 hours for RT environment.

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Table 11-49. DDM-2000 OC-12 Circuit Pack Reliability (Note 1)

	CO		RT	
Circuit Pack	**FITS (Note 2)**	**MTBF (Years)**	**FITS (Note 2)**	**MTBF (Years)**
BBF2B (TGS)	1935	59.0	2903	39.3
BBF2C (TGS)	2345	48.68	3518	32.45
BBF4 (TG3)	2311	49.40	3467	32.93
BBG5 (SYSCTL)	3032	37.6	4548	25.1
BBG8 (SYSCTL)	4505	25.3	6758	16.9
BBG8B (SYSCTL)	4442	25.7	6663	17.1
BCP1 (OHCTL)	3398	33.6	5097	22.4
BCP2 (TSI)	1925	59.3	2888	39.5
BCP3 (TSI)	2083	54.8	3125	36.5
BCP4 (OHCTL)	4345	26.3	6518	17.5
BBG11 (3DS3)	1912	59.7	2868	39.8
BBG11B (3DS3)	2880	39.6	4320	26.4
BBG12 (3STS1E)	1695	67.3	2543	44.9
21D (OLIU)	1422	80.2	2133	53.5
21D-U (OLIU)	1355	84.2	2033	56.1
21G (OLIU)	6103	18.7	9155	12.5
21G-U (OLIU)	6083	18.8	9125	12.5
21G2-U (OLIU)	3714	30.7	5571	20.5
21G3-U (OLIU)	1768	64.57	2652	43.04
23G (OLIU)	7595	15	11393	10
23G-U (OLIU)	3712	30.7	5568	20.5
23H (OLIU)	9222	12.4	13833	8.2
23H-U (OLIU)	9574	11.9	14361	7.9

Notes:

1. Calculations are based on Telcordia Technologies RPP Issue 6 data. All KS and Lucent components considered as quality level III. All components evaluated at 40°C ambient and 50 percent electrical stress.
2. FITS is the number of failures per billion hours of operation (10^9).

Table 11-50. DDM-2000 Fan Shelf Steady State Failure Rates (Based on Telcordia Technologies RPP Issue 6 Data)

DDM-2000 Fan Shelf	Failures /10^9 hrs. RPP Prediction	MTBF (years)
ED-8C733,G8 Fan Shelf	9879*	11.56
ED-8C733-30,G6 Fan Unit	2000	57.08

* This includes failure rates for individual fan units.

OC-12 Regenerator

This section provides technical specifications for the OC-12 Regenerator.

The OC-12 Regenerator transmission interfaces adhere to industry standards as listed in Table 11-51.

Table 11-51. Transmission Interface Standards

Interface	Standard
OC-12	*ANSI* * T1.106/88, *ANSI* T1.105/91, TR-253, Iss. 2, TR-496, Iss 3

* Registered trademark of American National Standards Institute.

External Transmission Interfaces

Long Reach OC-12 Interface (23R-U REGENR)

- Optical Specification

  The 23R-U REGENR* photonics meet or exceed SONET long reach specifications (TR-LR-1 MLM category). The multilongitudinal laser transmitter supplies an NRZ-coded signal. The receiver requires the use of an external attenuator for direct optical loopback and short spans.

  The 23R-U REGENR long reach OC-12 interface supports span lengths up to 51 km (32 miles), assuming 0.45 dB/km single-mode fiber (including splices) and the span engineering rules outlined in Table 11-53. Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

  The 23R-U REGENR supports spans of 43 km (27 miles) at a 10^{-10} BER using single-mode fiber and NRZ line coding in an uncontrolled environment.

- Laser bias current is monitored on the 23R-U REGENR.

* The 23R-U REGENR has been classified discontinued availability.

Table 11-52 lists the 23R-U REGENR circuit pack specifications.

Table 11-52. 23R-U REGENR Circuit Pack Specifications

System Information:	
Terminal Equipment Identification	23R-U REGENR
Optical Line Rate (Mb/s)	622.080 Mb/s
Optical Line Coding	Scrambled NRZ
Optical Wavelength	1310 nm
Performance	SONET LR-1 MLM (Long Reach)
Transmitter Information:	
Optical Device Temperature Controller	TEC
FDA Classification	Class I
Optical Source	InGaAsP Laser, MLM Structure
Faceplate Optical Connector	UOC Buildout Assembly *
Receiver Information:	
Optical Device Temperature Controller	None
Optical Detector	Ge APD/InGaAs PIN
Faceplate Optical Connector	UOC Buildout Assembly * (23R-U)

* The universal optical connector (UOC) buildout assembly consists of a faceplate-mounted block assembly and either 0 dB, 5 dB, 10 dB, or 15 dB buildout in either ST, SC, or FC-type connectors.

Table 11-53. OC-12 Regenerator Link Budgets (Note 1)

Parameter	23R-U (Note 2)
Minimum Wavelength (λ_{Tmin})	1298 nm
Maximum Wavelength (λ_{Tmax})	1325 nm
Spectral Width* ($\delta\lambda_{rms}$)	2.0 nm
Maximum Transmitter Power† (P_{Tmax})	+2.0 dBm
Minimum Transmitter Power (P_{Tmin})	–2.5/–3.0 dBm‡
Maximum Received Power (P_{Rmax})	–8.0 dBm
Minimum Received Power (P_{Rmin})	–30.5/–27.5 dBm‡
Minimum System Gain (S-R)§	28.0/24.5 dBm‡
Optical Path Penalty (P_O)¶	2.0 dB
Connector Loss**	1.5 dB
Unallocated Margin††	1.5 dB
Minimum Loss Budget‡‡	10.0 dB
Maximum Loss Budget§§	23.0/19.5 dB‡
Maximum Span Length¶¶	51/43 km

Notes:

1. All terminology is consistent with TR-253, Iss. 2. All values are worst-case end of life.
2. All specifications for the 23R-U meet or exceed long reach (LR) values described in TR-253, Iss. 2. This loss budget applies to 1310 nm optical signals transmitted and received by the 23R-U.

* RMS spectral width for the 23R-U.

† Transmit and receive powers are referenced to points S and R as shown in Figure 11-2.

‡ When two numbers are given, the number before the slash is the specification for operating under controlled environmental conditions. The number following the slash is the specification for uncontrolled environmental conditions. If only one number is given, it applies to both controlled and uncontrolled environmental conditions.

§ The minimum system gain for the DDM-2000 already takes into account aging, temperature, and manufacturing tolerances as these figures are built into the minimum transmitter power. The DDM-2000 system gain can, thus, not be directly compared with the DDM-1000 system gain because the DDM-1000 system gain does not include all of these effects. A similar penalty, called eye margin, is subtracted from the DDM-1000 loss budget after the value of system gain is determined.

¶ Optical path penalty includes effects of dispersion, reflection, and jitter that occur on the optical path. The 23R-U has 5.0 dB of total margin. Optical path penalty is normally 1.0 dB. This allows for a maximum dispersion of 92 psec/nm in the 1310 nm wavelength range. To allow for span lengths greater than 40 km, 2.0 dB is allocated for optical path penalty. This allows a maximum dispersion of 120 ps/nm.

** One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.

†† Unallocated margin, or safety margin, is typically specified from 0 dB to 3 dB.

‡‡ The 23R-U requires an external lightguide buildout as part of the connector assembly for loopbacks and for OSP budgets less than 10 dB. Includes a 1.5 dB safety margin.

§§ Budget available for both station and transmission cable and splices.

¶¶ Attenuation and dispersion can be the limiting factors in span length. For OC-12 systems, the maximum distance could be either attenuation limited or dispersion limited. The limits must be calculated based on both factors and the lesser of the two defines the actual maximum span length. A rough rule of thumb for attenuation-limited systems operating at the 1310 nm wavelength range is 0.45 dB/km. This estimate includes typical cable loss (0.4 dB/km) and splice loss (0.2 dB per splice, 11 total splices) associated with single-mode fiber in the 1310 nm range.

Allowing 2.0 dB for the optical path penalty implies 120 ps/nm total dispersion in the 1310 nm wavelength range. Typical maximum slope for single-mode fiber in this wavelength is 0.092 ps/nm squared per km. Typical nondispersion shifted fiber has a zero dispersion wavelength between 1300 and 1320 nm. Given these assumptions, the maximum span length for the 23R-U is 51km.

Maximum span length can be calculated more precisely based on particular fiber and splice characteristics and local engineering rules.

SONET Overhead Bytes

The OC-12 Regenerator does not use any reserved or unused bytes in the SONET format for proprietary end-to-end signaling on OC-12 interfaces.

Performance

Wander/Jitter

- The REGENR circuit pack accommodates at least 10 microseconds of wander per 24-hour period.
- Jitter transfer, tolerance, and generation requirements are met as specified in TR-253, Iss. 2, and TR-499, Iss. 5 (Category II).

Transient Performance

Power Loss Restart

After system shutdown due to power loss, the system will exhibit a 2-second error free transmission interval which begins within 1 minute of restoration of power.

Performance Monitoring

Table 11-54 shows the provisionable range of the thresholds for monitored parameters and, in parentheses, the default thresholds. Thresholding of any parameter can be disabled.

Table 11-54. OC-12 Regenerator Performance Monitoring Parameters Provisionable Via the CIT

Parameter Definition		Threshold Range [Default]		Command
Facility	Measure	Current Quarter Hour	Current Day	**set-pmthres-**
OC-12 Optics	Laser Bias Current *	enabled/disabled	enabled/disabled	**sect**
OC-12 Section	SEFS	1-63[10]	1-4095[30]	**sect**
OC-12 Line	B2 Coding Violations (CV)	1-55365[5537]	1-5315040[531504]	**line**
	B2 Errored Seconds (ES)	1-900[40]	(1-65535)[900]	**line**
	B2 Errored Seconds Type A (ESA)	1-900[30]	(1-65535)[90]	**line**
	B2 Errored Seconds Type B (ESB)	1-900[30]	(1-65535)[90]	**line**
	B2 Severely Errored Seconds (SES)	1-63[20]	(1-4095)[60]	**line**
	B2 Unavailable Seconds (UAS)	1-63[30]	(1-4095)[90]	**line**

* Threshold is set once for both current quarter-hour and current day.

User Panel

Since the OC-12 Regenerator is not intended as a centralized network maintenance and operations center, the FE ACTY LED and the FE SEL LED pushbuttons are not operational.

OC-12 Regenerator TL1/X.25 Interface

The OC-12 Regenerator Release 2.0 supports a TL1/X.25 interface for communication with alarm surveillance and provisioning OSs, such as Telcordia Technologies NMA and OPS/INE. The OC-12 Regenerator TL1/X.25 interface is based on Telcordia Technologies TR-TSY-000831, Issue 2. The OC-12 Regenerator supports two X.25 permanent virtual circuits (PVCs) assigned as shown in Table 11-55.

Table 11-55. OC-12 Regenerator TL1/X.25 Interface — VC Assignments

PVC ID	SVC ID	Logical Group #	Logical Channel #	Use
1		0	1	Command/Response Messages
2		0	2	Autonomous Maintenance Messages and Command/Response Messages

At the packet layer, OC-12 Regenerators are configured as a passive DTE with the following parameters as shown in Table 11-56.

Table 11-56. OC-12 Regenerator TL1/X.25 Interface — X.25 Packet Layer Parameters

Parameter	Value
Packet Size	256 bytes
Window Size	2 packets
D bit support	NO
M bit support	YES

At the link layer, the OC-12 Regenerator uses the standard LAPB protocol with the following parameters as shown in Table 11-57.

Table 11-57. OC-12 Regenerator TL1/X.25 Interface — LAPB Link Layer Parameters

Parameter	Value
Maximum Frame Size	2104 bits
Modulo	8
Window Size	7 frames
n2	7 retires
T1	3 seconds
T3	20 seconds

The OC-12 Regenerator uses synchronous, full duplex, and continuous carrier communication. Data rates of 1200, 2400, 4800, 9600, and 19,200 are supported. The EIA-232-D interface is configured as DTE, using the pin connections specified in Table 11-58.

Table 11-58. OC-12 Regenerator TL1/X.25 Interface - EIA-232-D Pin Connections

Pin	Description
2	Transmitted Data
3	Received Data
4	Request to Send
5	Clear to Send
6	DCE Ready
7	Signal Ground
8	Received Line Signal Detector
15	Transmitted Signal Element Timing (DCE to DTE)
17	Receiver Signal Element Timing (DCE to DTE)
20	DTE Ready *

* DTE is always on when system is powered.

Physical Specifications

OC-12 Regenerator Shelf Physical Characteristics

- Dimensions: 14 in. H x 21.25 in. W x 12 in. D
- Weight: approximately 60 lb. (27 kg) with a full complement of circuit packs
- Appearance: coordinated with other equipment in the Lucent 2000 Product Family.

Network Bay Mounting

OC-12 Regenerators can be mounted in ED-8C500, ED-8C501, ED-8C800 (seismic), and ED-8C801 (seismic) network bay frames. A maximum of three OC-12 Regenerator shelves can be mounted in a 7-foot bay.

OC-12 Regenerator Reliability

Summary

The OC-12 Regenerator meets all the applicable Telcordia Technologies reliability requirements that cover transmission availability, operations systems availability, optical module maintenance, and infant mortality. The basis for these requirements comes from TA-TSY-000418, "*Generic Reliability Assurance Requirements for Fiber Optic Transport Systems*."

Circuit Pack Reliability

Table 11-59 lists the circuit pack reliability for the OC-12 Regenerator.

Table 11-59. OC-12 Regenerator Circuit Pack Failure Rates (Note 1)

	CO		RT	
Circuit Pack	**FITS (Note 2)**	**MTBF (Years)**	**FITS (Note 2)**	**MTBF (Years)**
BBG5 (SYSCTL)	5284	21.60	7926	14.40
BCP1 (OHCTL)	5050	22.61	7575	15.07
23R-U (REGENR)	9807	11.64	14711	7.76

Notes:

1. Calculations are based on Telcordia Technologies RPP Issue 6 data. All KS and Lucent components considered as quality level III. All components evaluated at 40°C ambient and 50 percent electrical stress.
2. FITS is the number of failures per billion hours of operation (10^9).

System Reliability Predictions

Table 11-60 lists the system reliability predictions for the OC-12 Regenerator.

Table 11-60. OC-12 Regenerator System Reliability Predictions

		Prediction	
Criteria	**Telcordia Objective**	**Controlled Environment**	**Uncontrolled Environment**
OC-12 transmission outage using four REGENRs (minutes/year)	0.1	0.00095	0.00859
MTBF of Regenerator System with four REGENRs, one SYSCTL, and one OHCTL (years)	1.5	7	8
MTBF Optical TX/RX Module (years)	4	13.65	9.1

A SONET Overview

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A SONET Overview

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Overview

This section briefly describes the Synchronous Optical Network (SONET).

History

In the early 1980's, the American National Standards Institute (ANSI) recognized the need for an optical signal standard for future broadband transmission. The ANSI T1X1 subcommittee began working on optical signal and interface standards in 1984. In 1985, Bellcore proposed a network approach to fiber system standardization to T1X1. The proposal suggested a hierarchical family of signals whose rates would be **integer multiples** of a basic modular signal. The proposal further suggested a synchronous multiplexing technique, leading to the coining of the term *Synchronous Optical NETwork* (SONET).

The International Telephone and Telegraph Consultative Committee (CCITT) first showed interest in 1986. Conferences held through 1987 and 1988 resulted in coordinated specifications for both the American National Standard (SONET) and the CCITT-International Standard, Synchronous Digital Hierarchy (SDH). Approval of both sets of standards occurred in late 1988.

Basic Purpose

The basic purpose of SONET is to provide a standard synchronous optical hierarchy with sufficient flexibility to accommodate digital signals that currently exist in today's network as well as those planned for the future.

SONET currently defines standard rates and formats and optical interfaces. These and other related issues continue to evolve through the ANSI committees. SONET ultimately will permit an optical midspan meet in a multivendor environment.

The American National Standard defines the following:

- Optical parameters (*ANSI** T1.106-1988)
- Electrical parameters (*ANSI* T1.102-1993 Draft)
- Multiplexing schemes to map existing digital signals (for example, DS1, DS2, and DS3) into SONET payload signals (*ANSI* T1.105-1991)
- Criteria for optical line automatic protection switch (APS) (*ANSI* T1.105-1991)
- Overhead channels to support standard operation, administration, maintenance, and provisioning (OAM&P) functions (*ANSI* T1.105-1991).

*

Technical Overview

SONET Signal Hierarchy

The SONET signal hierarchy is based on a basic "building block" frame called the synchronous transport signal - level 1 (STS-1), as shown in Figure A-1 on the following page. The STS-1 frame has a reoccurring rate of 8000 frames per second. Each frame is 125 microseconds.

The STS-1 frame consists of:

- 90 columns (each column is an 8-bit byte)
- 9 rows.

* Registered trademark of America National Standards Institute.

The STS-1 frame is transmitted serially starting from the left with row 1 column 1 on through column 90, then row 2 column 1 through 90, continuing on, row-by-row, until all 810 bytes (9 X 90) of the STS-1 frame have been transmitted.

Since each STS-1 frame consists of 810 bytes and each byte has 8 bits, the frame contains 6480 bits a frame. There are 8000 STS-1 frames per second, at the STS-1 signal rate of 51,840,000 (6480 X 8000) bits a second.

The first three columns in each of the nine rows carry the SECTION and LINE overhead bytes. Collectively, these 27 bytes are referred to as transport overhead.

The remainder of the frame, columns 4 through 90, is reserved for payload signals (for example, DS1, DS3, and path overhead) and is referred to as the STS-1 synchronous payload envelope (STS-1 SPE). The optical counterpart of the STS-1 is the optical carrier level 1 signal (OC-1), which is the result of a direct optical conversion. The electrical counterpart of the STS-1 is the electrical carrier level 1 signal (EC-1).

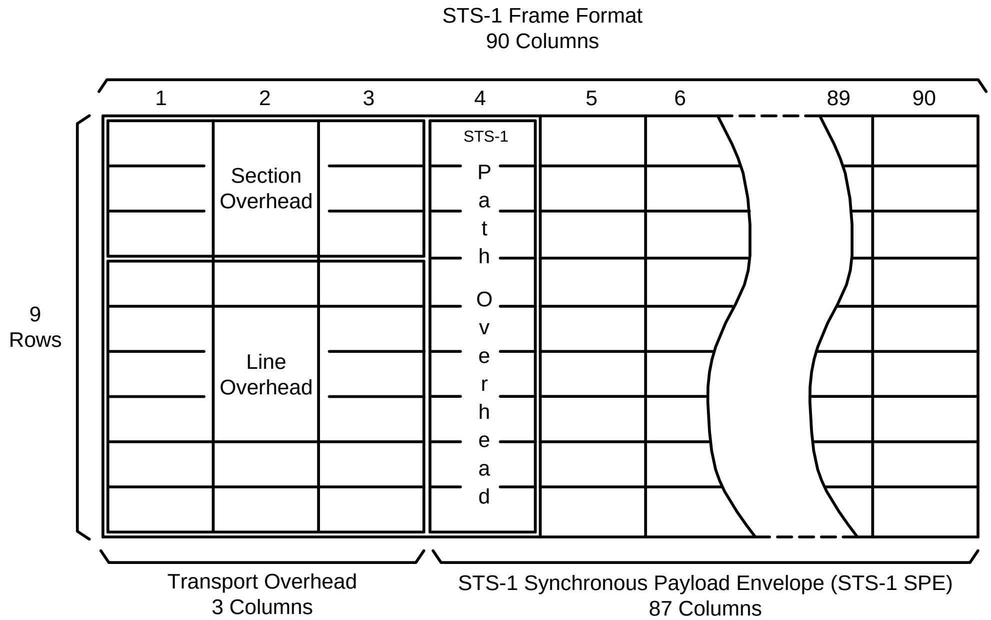


Figure A-1. SONET STS-1 Frame — Simplified Version

SONET Layers

SONET divides its processing functions into three layers. These three layers are associated with equipment that reflects the natural divisions in network spans. Figure A-2 shows these defined layers in a signal path. They include:

- **SECTION** and **Section Terminating Equipment** - the transmission spans between lightwave terminating equipment and the regenerators. The spans between the regenerators are also considered sections. Section terminating equipment provides regenerator functions and terminates the section overhead to provide single-ended operations and section performance monitoring.
- **LINE** and **Line Terminating Equipment** - the transmission span between terminating equipment (STS-1 cross-connections) that provides line performance monitoring. If there are no intervening repeaters, the line terminating equipment also functions as section terminating equipment.
- **STS-1 and VT Path** and **Path Terminating Equipment** - the transmission span for an end-to-end tributary (DS1 or DS3) signal that provides functions including signal labeling and path performance monitoring for signals as they are transported through a SONET network. STS-1 path terminating equipment can also provide cross-connections for lower rate (that is, DS1) signals. A virtual tributary (VT) is a sub-DS3 payload and is described later in more detail.

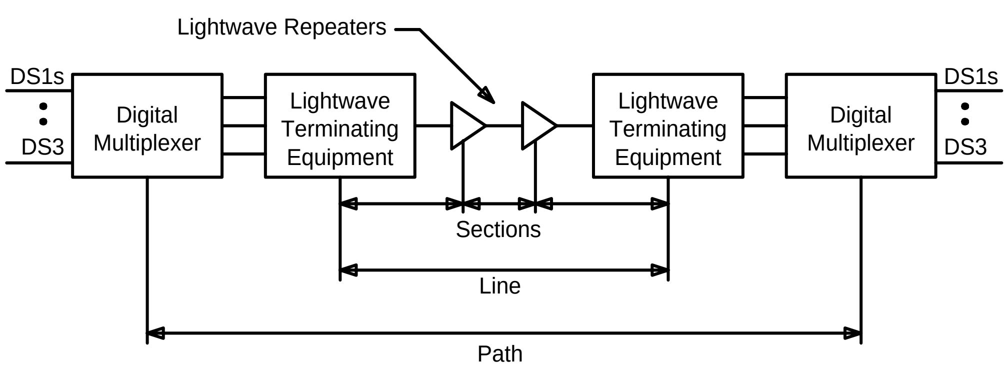


Figure A-2. Section, Line, and Path Definitions

Each SONET layer has a set of overhead bytes as shown in Figure A-3. These bytes carry information used by various network elements.

- **Section Overhead** contains information that is used by all SONET equipment including repeaters.
- **Line Overhead** is used by all SONET equipment except repeaters.
- **Path Overhead** is carried within the payload envelope.
  - — **STS-1 path overhead** remains with the STS-1 SPE until its asynchronous signal is extracted (for example, DS-3) or until its individual VT1.5 signals are demultiplexed.
  - — **VTN (N= 1.5, 2, 3, or 6) path overhead** remains with the VTN until its asynchronous signal is extracted.

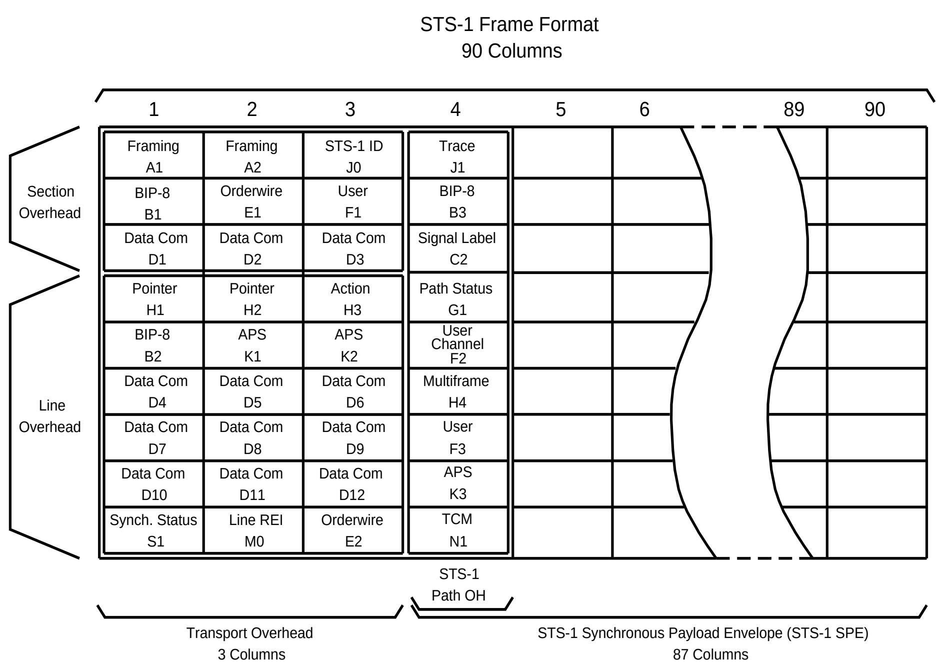


Figure A-3. SONET Frame Format

SONET Frame Structure

The following pages provide more detailed information on the function of various overhead bytes for each SONET layer.

Section Overhead

- Framing (A1, A2)
  - Provides framing for each STS-1.
- STS-1 ID (J0)
  - Provides the order of appearance in a byte-interleaved STS-*N* frame; for example, STS-1 #1, STS-1 #2......STS-1 #48. In future applications, this byte will provide a section trace function. For information on STS-*N* signals, see the "Higher Rate Transport" part of this section.
- Section Bit-Interleaved Parity (BIP-8) (B1)
  - Provides SECTION performance monitoring and is calculated over all bits of the previous STS-*N* frame. Defined only for STS-1 #1 of an STS-*N* signal.
- Section Order Wire (E1)
  - Provides a local order wire for voice communication channel between section terminating network elements, such as repeaters. Defined only for STS-1 #1 of an STS-*N* signal.
- Section User Channel (F1)
  - Set aside for the user's purpose. Defined only for STS-1 #1 of an STS-*N* signal.
- Section Data Communications Channel (D1, D2, D3)
  - Is a 192 kb/s message-based channel. Used for alarms, maintenance, control, monitoring, and other communication needs between section terminating equipment. Defined only for STS-1 #1 of an STS-*N* signal.

Line Overhead

- Line Pointer (H1, H2)
  - Two bytes indicate the offset in bytes between the pointer action byte (H3) and the first byte (J1) of the STS-1 synchronous payload envelope (SPE).
- Pointer Action (H3)
  - One byte is allocated for frequency justification.
- Line Bit-Interleaved Parity (BIP-8) (B2)
  - This byte is for line performance monitoring. This byte is provided in all STS-1 signals within an STS-*N* signal.
- Line Automatic Protection Switching (APS) (K1, K2)
  - Two bytes used for APS signaling between line level entities. In addition, bits 6, 7, and 8 of K2 are used for line alarm indication signal (AIS) and line far-end receive failure (FERF). Defined only for STS-1 #1 of an STS-*N* signal.
- Line Data Communications Channel (D4 - D12)
  - Is a 576 kb/s message-based channel.
- Synch. Status (S1)
  - In STS-1 #1, the S1 byte is for synchronization status messages, and only bits 5 through 8 are used.
- Line REI (M0)
  - The M0 byte is for STS-1 line far-end block error (FEBE), and only bits 5 through 8 are used.
- Line Orderwire (E2). Defined only for STS-1 #1 of an STS-*N* signal.
  - One byte is allocated to be used as an express orderwire between line terminating equipment.

Path Overhead

There are two types of path overheads:

— STS-1 path overhead

— VT path overhead.

STS-1 Path Overhead

The STS-1 path overhead is assigned to and remains with the STS-1 SPE until the payload is extracted and is used for functions that are necessary to transport all synchronous payload envelopes.

- STS-1 Path Trace (J1)
  — Repetitively transmits a 64 byte, fixed length, string so that an STS-1 path receiving terminal can verify its continued connection to the intended transmitter.
- STS-1 Path Bit-Interleaved Parity (BIP-8) (B3)
  — Provides each STS-1 path performance monitoring. This byte is calculated over all bits of the previous STS-1 SPE before scrambling.
- STS-1 Path Signal Labels (C2)
  — Indicates the construction of the STS-1 SPE. A value of 00000000 indicates an unequipped STS-1 SPE. Values for various payload mappings are defined in TR-NWT-000253, Issue 2.
- STS-1 Path Status (G1)
  — Conveys the STS-1 path terminating status, far end block errors (FEBE), and yellow alarm signal conditions back to an originating STS-1 path terminating equipment.
- STS-1 Path User Channel (F2, F3)
  — User communication channel between Path elements.
- VT Multiframe Indicator (H4)
  — Provides a general multiframe indicator for VT-structured payloads.
- STS-1 Path Automatic Protection Switching (K3)
  — Path Automatic Protection Switching
- TCM - Tandem Connection Maintenance (N1)
  — Bits 1-4 used for incoming error monitoring. Bits 5-8 used as communications channel.

VT Path Overhead

There is one byte of VT path overhead called V5. It occurs on every fourth frame; that is, 2000 times a second.

This byte provides for VT paths the same functions that B3, C2, and G1 provide for STS paths, namely:

- Error checking
- Signal label
- Path status.

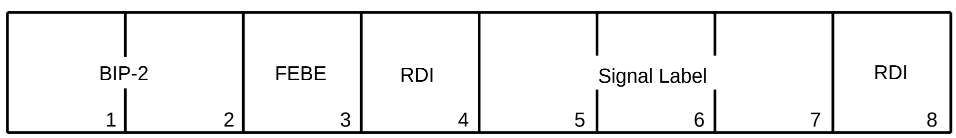
The bit assignments of the VT path overhead are specified in the following list and are illustrated in Figure A-4:

— Bits 1 and 2 are used for error performance monitoring (BIP-2).

— Bit 3 is a VT path far-end-block-error (FEBE) indication that is sent back toward an originating VT PTE when errors are detected by the BIP-2.

— Bit 4 and Bit 8 are used for remote defect indication (RDI)

— Bits 5 through 7 provide a VT signal label.



VT Path Signal Label Coding:

0 0 0	Unequipped
0 0 1	Equipped-Nonspecific

Figure A-4. VT Path Overhead Byte

SONET Multiplexing Procedure

SONET has provisions for multiplexing asynchronous DS1s, synchronous DS1s, and asynchronous DS3s. Refer to Figure A-5 and Figure A-6.

The first stage in multiplexing is mapping the input DS1 or DS3 tributary. In the case of DS1 inputs, three time slots (DS0s) are added to the incoming signal thus becoming a VT1.5. An asynchronous DS1 that fully meets the specified rate is mapped into the VT1.5 SPE as clear channel input since no framing is needed.

- Each VT1.5 carries a single DS1 payload.
- Four VT1.5s are bundled into a VT group (VT-G).
- Seven VT-Gs are byte-interleaved into an STS-1 frame.

The VT-G to-STS-1 multiplex is a simple byte-interleaving process, so individual VT signals are easily observable within the STS-1. Thus, cross-connections and add/drop can be accomplished without the back-to-back multiplexing/multiplexing steps required by asynchronous signal formats. The structured VTs are now multiplexed into the STS-1 SPE, and the path, line, and section overhead are added. The final multiplexing, as shown in Figure A-5, provides the scrambled STS-*N* signal to the optical conversion stage.

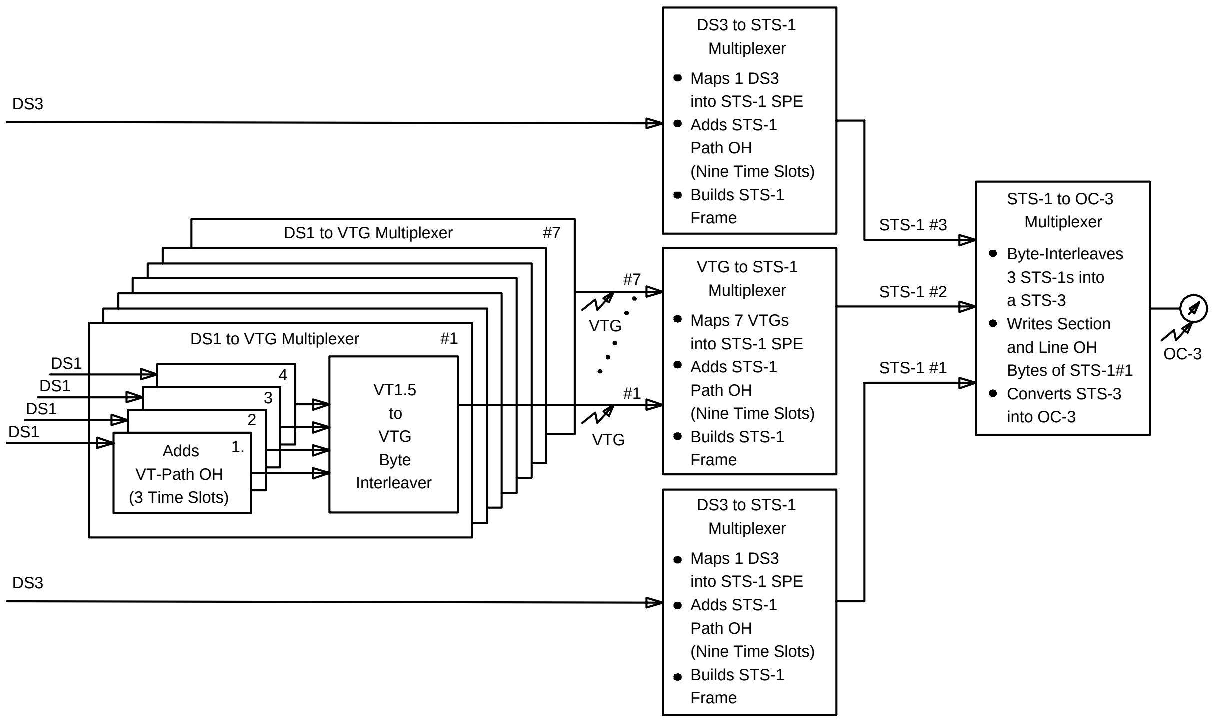


Figure A-5. SONET Multiplexing Procedure

SONET Demultiplexing Procedure

As shown in Figure A-6, demultiplexing is the inverse of multiplexing. The unscrambled STS-1 signal from the optical conversion stages is processed to extract the section and line overhead and accurately locate the SPE. The next stage processes the path overhead and demultiplexes the VTs. A standard DS3 signal will be provided to the asynchronous network after path overhead processing. For DS1 signals, the individual DS1 VTs are then processed to extract VT overhead and, via the VT pointer, accurately locate the DS1 SPE. Finally, desynchronization of the DS1 SPE provides a standard DS1 signal to the asynchronous network.

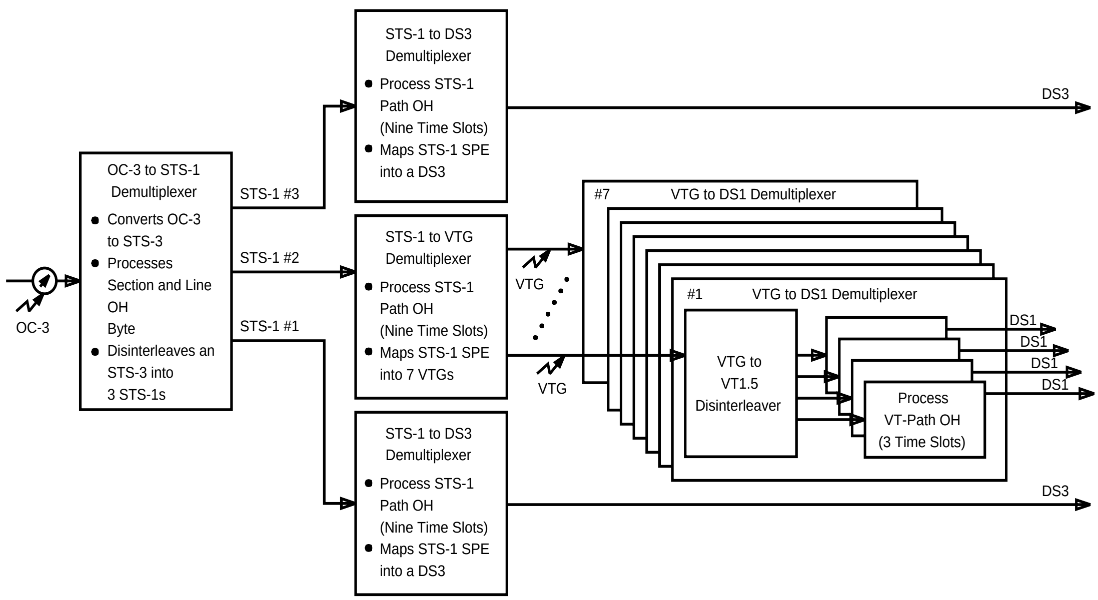


Figure A-6. SONET Demultiplexing Procedure

Two key points should be noted at this time. First, the SONET frame is a fixed time (125 µs) and no bit-stuffing is used. Second, as shown in Figure A-7, the synchronous payload envelope can *float* within the frame using byte-stuffing. This is to permit compensation for small variations in frequency between the clocks of the two systems that may occur if the systems are independently timed (plesiochronous timing). The SPE can also drift across the 125-µs frame boundary. SONET STS pointers are used to locate the SPE relative to the transport overhead.

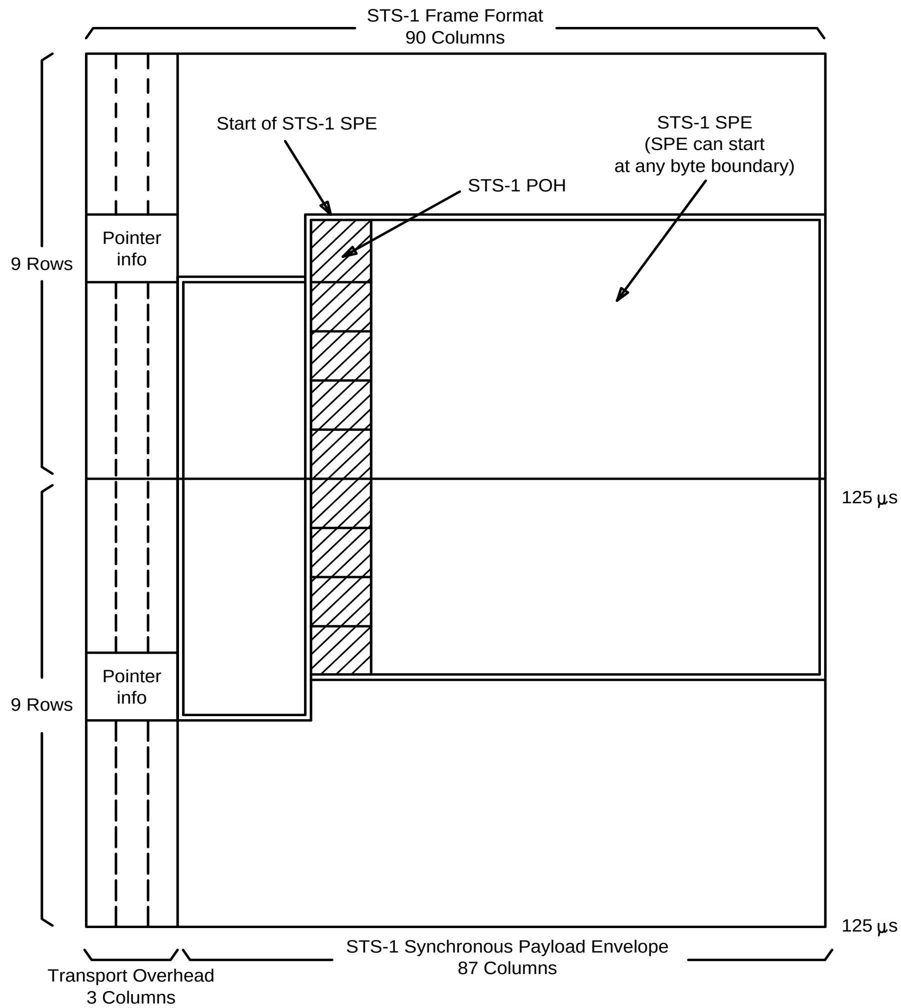


Figure A-7. STS-1 Synchronous Payload Envelope in Interior of STS-1 Frame

SONET Digital Multiplexing Schemes

Asynchronous Multiplexing

Currently, fiber optic facilities are primarily used to carry DS3 signals. The DS3 signal consists of a combination of the following payload signals:

- 28 DS1s
- 14 DS1Cs
- 7 DS2s.

Typically, 28 DS1 signals are multiplexed into a DS3 signal, using an M13 format. Refer to Figure A-8. M13 format is a process that includes bit-interleaving four DS1 into a DS2 signal and then bit-interleaving seven DS2 signals into a DS3. The DS3 rate is not a direct multiple of the DS1 or the DS2 rates due to the bit-stuffing synchronization technique used in asynchronous multiplexing.

Identification of DS0s contained in any DS-*N* signal, except DS1, is complex and DS0s cannot be directly extracted. Thus, an asynchronous DS3 signal must be demultiplexed down to the DS1 level to access and cross-connect DS0 and DS1 signals.

Another disadvantage of the M13 format is there is no end-to-end overhead channel for use by OAM&P groups.

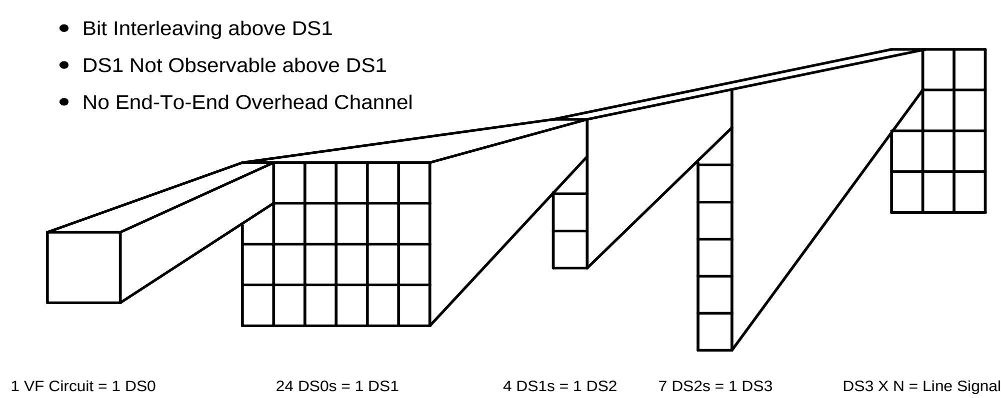


Figure A-8. Asynchronous Multiplexing

Synchronous Multiplexing

SONET's method of *byte-interleaving* DS1s to a higher signal rate permits economical extraction of a single DS1 without the need to demultiplex the entire STS-1 SPE. In addition, SONET provides overhead channels for use by OAM&P groups.

In SONET, a single asynchronous DS3 signal is mapped into an STS-1 SPE (Figure A-9).

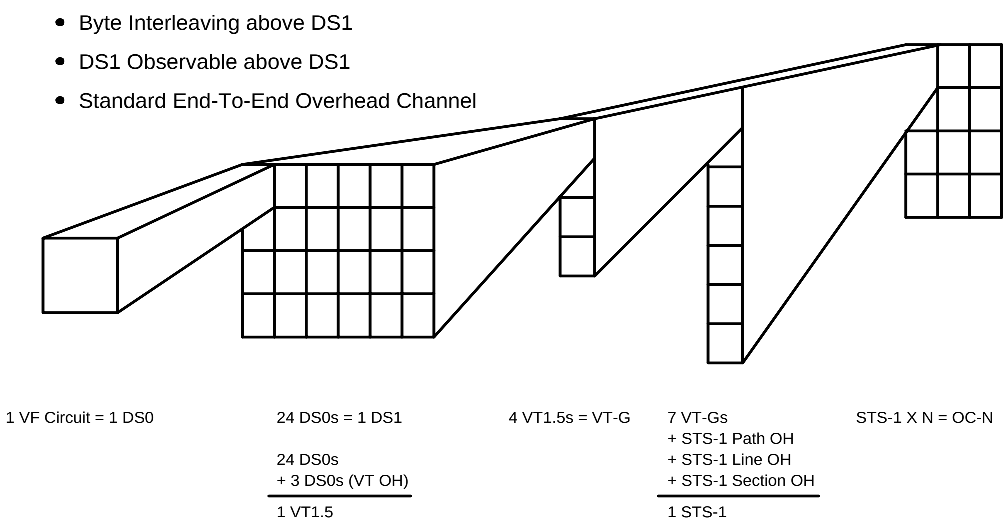


Figure A-9. Synchronous Multiplexing

Virtual Tributary Signals

Sub-DS3 asynchronous signals (DS1, DS1C, DS2 and E1) are *byte-interleaved* into a digital signal called a virtual tributary (VT). The VT is a structure designed for the transport and switching of sub-DS3 payloads. Like the STS-1 signal, the VT signal has a floating pointer that allows each VT SPE to move within the VT structure. There are four sizes of virtual tributaries (VT1.5, VT2, VT3, VT6). Higher rate payloads are transported as one or more concatenated STS-1 signals.

Concatenated Mode

For services requiring multiples of the STS-1 rate, STS-1 path payloads may be shared to create a single broadband payload called a concatenated STS-*N*c (OC-*N*c). STS-1 signals are mapped into an STS-*N*c SPE and transported as a concatenated STS-*N*c signal. This STS-*N*c signal can be carried by an STS-*N* or OC-*N* (or higher level) line signal.

The STS-*N* signal is multiplexed, switched, and transported through the network as a single entity. A concatenation indicator, used to show that the STS-1s of the STS-*N*c signal are linked together, is contained in the STS-1 payload pointer of all but the first STS-1. The line and section overhead is sent on the first STS-1 and the payload pointer for the first STS-1 is applied to all STS-1 signals in the concatenated signal.

Figure A-10 shows an example of an STS-3c SPE. It consists of 3 x 87 columns and 9 rows of bytes. The order of transmission is row by row, from left to right.

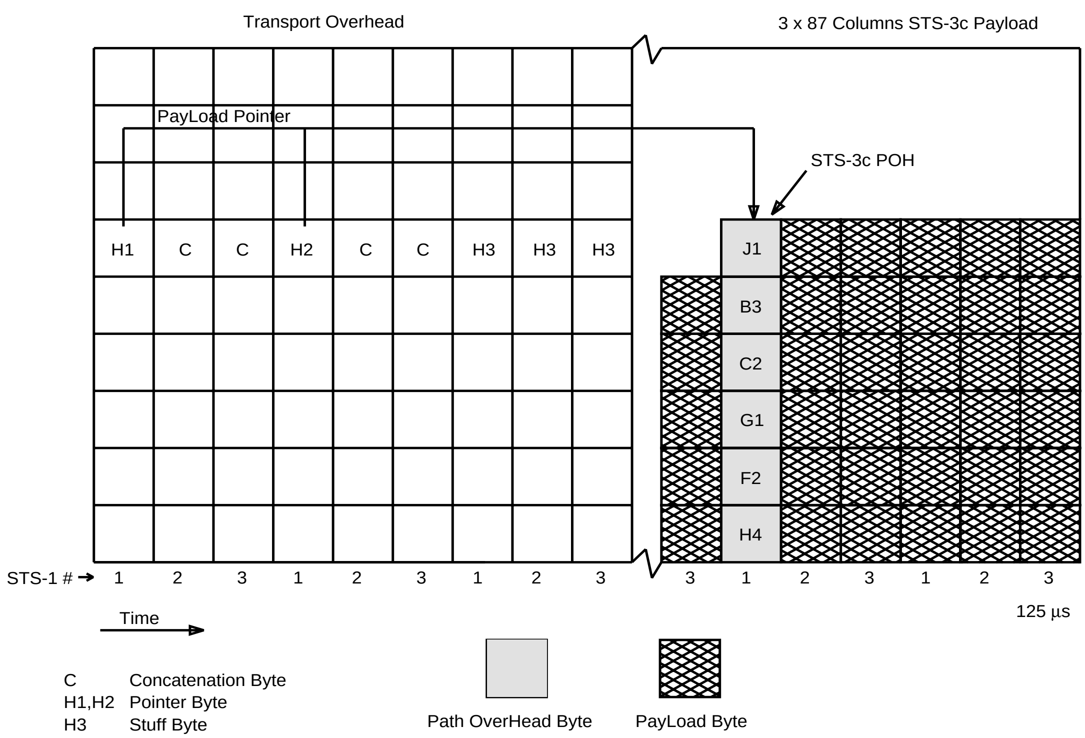


Figure A-10. STS-3c Concatenated Payload

SONET Interface

The SONET interface (Figure A-11) provides the optical midspan meet between SONET network elements. A SONET network element is the hardware and software that processes one or more layers of the SONET signal.

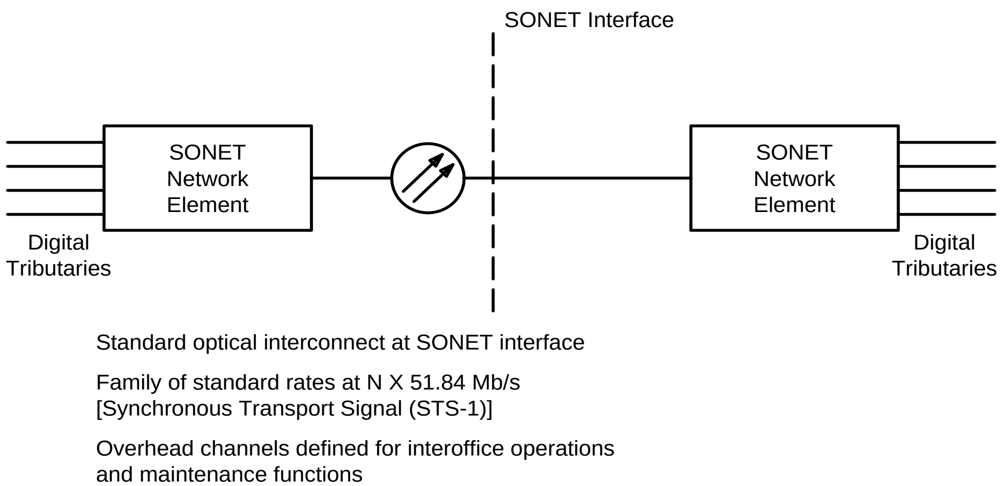


Figure A-11. SONET Interface

SONET Payloads

Table A-1 shows the digital signals that can be transported as SONET payloads.

Table A-1. SONET Payloads

Input Tributary	Equivalent Channels	Rate	SONET Signal	Rate
DS1	24 DS0s	1.544 Mb/s	VT1.5	1.728 Mb/s
E1 (CEPT)	32 DS0s	2.048 Mb/s	VT2	2.304 Mb/s
DS1C	48 DS0s	3.152 Mb/s	VT3	3.456 Mb/s
DS2	96 DS0s	6.312 Mb/s	VT6	6.912 Mb/s
DS3	672 DS0s	44.736 Mb/s	STS-1	51.840 Mb/s
DS4NA	2016 DS0s	139.624 Mb/s	STS-3c	150.336Mb/s
ATM		149.76 Mb/s	STS-3c	150.336Mb/s
FDDI		125.00 Mb/s	STS-3c	150.336Mb/s
Future payloads		up to 150 Mb/s		
Future broadband payloads		Greater than 150 Mb/s		

DS1 and DS3 signals are the most important of these signals in the current network. Broadband payloads, such as asynchronous transfer mode (ATM) and fiber distributed data interface (FDDI), with rates of 150 Mb/s and higher, are also important. Other payloads may be defined for specific applications.

Higher Rate Transport

Higher rate SONET signals are created by byte-interleaving *N* STS-1 to form an STS-*N* signal. The STS-*N* is then scrambled and converted to an optical carrier - level *N* (OC-*N*) signal. The OC-*N* has a line rate of exactly *N* times the OC-1 signal (see Table A-2).

Table A-2. SONET Transport Rates

OC Level	Line Rate (Mb/s)	Capacity
OC-1	51.84	28 DS1s or 1 DS3
OC-3	155.52	84 DS1s or 3 DS3s
OC-9	466.56	252 DS1s or 9 DS3s
OC-12	622.08	336 DS1s or 12 DS3s
OC-18	933.122	504 DS1s or 18 DS3s
OC-24	1244.16	672 DS1s or 24 DS3s
OC-36	1866.24	1008 DS1s or 36 DS3s
OC-48	2488.32	1344 DS1s or 48 DS3s

Conclusion

The intent of this section is to present a short overview of SONET. More detailed expositions can be found in various literature. An excellent description of SONET can be found in Reference 3.

REFERENCES

1. ANSI T1.106-1988 •American National Standard for Telecommunications - Digital Hierarchy Optical Interface Specifications, Single Mode,• and ANSI T1.105-1991 •American National Standard for Telecommunications - Digital Hierarchy Optical Rates and Formats Specification.•
2. CCITT Recommendations G.707, G.708, G.709.
3. R. Ballert and Y. C. Ching, •SONET: Now It's the Standard Optical Network,• *IEEE Communications Magazine*, Vol. 27, No. 3 (March 1989): 8-15.
4. ANSI T1.102-1993 Draft •American National Standard for Telecommunications - Digital Hierarchy Electrical Interface Specifications.•

Glossary

0x1
See Ring (0x1) Low Speed Interface.

1+1
The 1+1 protection switching architecture protects against failures of the optical transmit/ receive equipment and their connecting fiber facility. One bidirectional interface (two fibers plus associated OLIUs on each end) is designated "service," and the other is designated "protection." In each direction, identical signals are transmitted on the service and protection lines ("dual-fed"). The receiving equipment monitors the incoming service and protection lines independently, and selects traffic from one line (the "active" line) based on performance criteria and technician/OS control. In 1+1 both service and protection lines could be active at the same time (service in one direction—protection in the other).

1xN, 1x1
1xN protection switching pertains to circuit pack protection that provides a redundant signal path through the DDM-2000 (it does not cover protection switching of an optical facility; see "1+1"). In 1xN switching, a group of N service circuit packs share a single spare protection circuit pack. 1x1 is a special case of 1xN, with N=1. In 1x1 only one is active at a time.

A

ABN
Abnormal (status condition)

ACO
Alarm Cutoff — A pushbutton switch available on the user panel that can be used to retire an audible office alarm.

ACO/TST
Alarm Cutoff and Test — The name of a pushbutton on the user panel.

Active
Active identifies a 1+1 protected OC-N line which is currently selected by the receiver at either end as the payload carrying signal or a 1x1 or 1xn protected circuit pack that is currently carrying service. (See Standby.)

ADM
Add/Drop Multiplexer.

AGNE
Alarm Gateway Network Element — A defined NE in an alarm group through which members of the alarm group exchange information.

AIS
Alarm Indication Signal — A code transmitted downstream in a digital network that shows that an upstream failure has been detected and alarmed.

AMI
Alternate Mark Inversion — A line code that employs a ternary signal to convey binary digits, in which successive binary ones are represented by signal elements that are normally of alternating, positive and negative polarity but equal in amplitude, and in which binary zeros are represented by signal elements that have zero amplitude.

ANSI
American National Standards Institute

APS
Automatic Protection Switch

ARM
Access Resource Manager

AS&C
Alarm, Status, and Control

ASCII
American Standard Code for Information Interchange — A standard 8-bit code used for exchanging information among data processing systems and associated equipment.

ASN.1
Abstract Syntax Notation 1

ASNE
Alarm Server Network Element.

ATM
Asynchronous Transfer Mode

Auto
Automatic — One possible state of a DS1 or DS3 port. In this state, the port will automatically be put "in service" if a good signal is detected coming from the DSX panel.

Automatic Protection Switch
A protection switch that occurs automatically in response to an automatically detected fault condition.

Automatic Synchronization Reconfiguration
A feature that allows another synchronization source to be automatically selected and the synchronization source provisioning to be automatically reconfigured in the event of a synchronization source failure or network synchronization change, for example, a fiber cut.

AUXCTL
Auxiliary Control — The name of the slot to the left of the SYSCTL slot on the DDM-2000 OC-3 and FiberReach wideband shelves and to the right of the SYSCTL slot on the DDM-2000 OC-12 shelf.

Available Time
In performance monitoring, the 1-second intervals.

B

B3ZS
Bipolar 3-Zero Substitution — A line coding method that replaces a string of three zeros with a sequence of symbols having some special characteristic.

B8ZS
Bipolar 8-Zero Substitution — A line coding method that replaces a string of eight zeros with a sequence of symbols having some special characteristic.

Backbone Ring
A host ring.

BDFB
Battery Distribution and Fuse Bay.

BER
Bit Error Ratio — The ratio of bits received in error to the total bits sent.

BIP
Bit Interleaved Parity — A method of error monitoring over a specified number of bits, that is, BIP-3 or BIP-8.

BITS
Building Integrated Timing Supply — A single clock that provides all the DS1 and DS0 synchronization references required by clocks in a building.

BRI
Basic Rate Interface

Broadband
Any communications channel with greater bandwidth than a voice channel; sometimes used synonymously with wideband.

C

CC
Clear Channel — A provisionable mode for the DS3 output that causes parity violations not to be monitored or corrected before the DS3 signal is encoded.

CCITT
International Telephone and Telegraph Consultative Committee — An international advisory committee under United Nations' sponsorship that has composed and recommended for adoption worldwide standards for international communications. Recently changed to the International Telecommunications Union Telecommunications Standards Sector (ITU-TSS).

CEV
Controlled Environment Vault

CD-ROM
Compact Disk, Read Only Memory

CDTU
Channel and Drop Test Unit

Channel
A logical signal within a port. For example, for an EC-1 port, there is one STS-1 channel and sometimes 28 VT1.5 channels. See Port.

Channel State Provisioning
A feature that allows a user to suppress reporting of alarms and events during provisioning by supporting multiple states (automatic, in-service and not monitored) for VT1.5 and STS-1 channels. See Port State Provisioning.

CIT
Craft Interface Terminal

CLF
Carrier Line Failure Status

CLK
Clock

CMISE
Common Management Information Service Element

CMOS
Complementary Metal Oxide Semiconductor

CO
Central Office

COACH
A system of on-line support tools aimed at providing product news and bulletins, diagnostic services, compatibility information, and on-line documents.

CP
Circuit Pack

CPE
Customer Premises Equipment

CR
Critical (alarm status)

CSA
Carrier Serving Area

CSU
Channel Service Unit

CS&O
Customer Support and Operations

CV
Coding Violation (a performance-monitoring parameter)

CVFE
Coding Violation Far-End — An indication returned to the transmitting terminal that an errored block has been detected at the receiving terminal.

D

DACS III-2000
Digital Access and Cross-Connect System that provides clear channel switching at either the DS3 or the STS-1 rates, eliminating the need for manual DSXs.

DACS IV-2000
Digital Access and Cross-Connect System that provides electronic DS3/STS-1 or DS1/VT1.5 cross-connect capability, eliminating the need for manual DSXs.

DCC
Data Communications Channel — The embedded overhead communications channel in the SONET line. It is used for end-to-end communications and maintenance. It carries alarm, control, and status information between network elements in a SONET network.

DCE
Data Communications Equipment — In a data station, the equipment that provides the signal conversion and coding between the data terminal equipment (DTE) and the line. The DCE may be separate equipment or an integral part of the DTE or of intermediate equipment. A DCE may perform other functions usually performed at the network end of the line.

DDM-1000
Lucent's Dual DS3 Multiplexer — A digital multiplexer that multiplexes DS1, DS1C, or DS2 signals into a DS3 signal or a 90 Mb/s or 180 Mb/s optical signal.

DDM-Plus
Lucent's optical and electrical DS1 transport system. DDM-Plus transports up to four DS1s per pair of optical fiber and can provide T1 extension over existing copper wires.

DDM-2000
Lucent's next generation network multiplexers that multiplex DS1, DS3, or EC-1 inputs into EC-1, OC-1, OC-3, or OC-12 outputs.

Default Provisioning
The parameter values that are preprogrammed as shipped from the factory.

Demultiplexing
A process applied to a multiplexed signal for recovering signals combined within it and for restoring the distinct individual channels of these signals.

DEMUX
Demultiplexer - "the DEMUX direction" is from the fiber toward the DSX.

Digital Multiplexer
Equipment that combines by time-division multiplexing several digital signals into a single composite digital signal.

DLC
Digital Loop Carrier

DPLL
Digital Phase-Locked Loop

DRI
Dual Ring Interworking. Two ring networks interconnected at two common nodes.

Drop and Continue
A technique that allows redundant signal appearances at two central offices in a DRI network, allowing protection against central office failures.

DS1
Digital Signal Level 1 (1.544 M/bs)

DS1 Circuit Pack
The DS1 interface circuit pack interfaces to the DSX-1 panel.

DS3
Digital Signal Level 3 (44.736 M/bs)

DS3 Circuit Pack
The DS3 circuit pack interfaces to the DSX-3 panel.

DSn
Digital Signal Rate n — One of the possible digital signal rates at DDM-2000 OC-3 and OC-12 interfaces: DS1 (1.544 Mb/s) or DS3 (44.736 Mb/s).

DSNE
Directory Services Network Element — A designated network element that is responsible for administering a database that maps network element names (TIDs) to addresses [NSAPs (network service access points)] in an OSI subnetwork. There can be one DSNE per ring. Can also be a GNE.

DSX
Digital Cross-Connect Panel — A panel designed to interconnect equipment that operates at a designated rate. For example, a DSX-3 interconnects equipment operating at the DS3 rate.

DT
Distant Terminal

DTE
Data Terminating Equipment — That part of a data station that serves as a data source (originates data for transmission), a data sink (accepts transmitted data), or both.

Dual 0x1 Cross-Connection

In a single-homed application, the DDM-2000 OC-3/OC-12 Multiplexer uses a dual 0x1 cross-connection to map the VT1.5 channels between the DDM-2000 FiberReach OC-1 and the DDM-2000 OC-3/OC-12 rings. This dual 0x1 architecture means that the VT1.5 path switching is only in the DDM-2000 FiberReach and not in the host DDM-2000. Individual DS1 signals within an STS-1 can therefore be dropped to DDM-2000 OC-3 shelves at several nodes around the ring. See Single 0x1.

Dual Homing

In DDM-2000 FiberReach, a network topology in which two OC-3 shelves serve as DDM-2000 FiberReach Multiplexer hosts supporting up to twelve OC-1 rings. Each DDM-2000 FiberReach Multiplexer ring is interconnected between the two separate hosts. Two *SLC*-2000 Access Systems serving as DDM-2000 FiberReach hosts can support up to four OC-1 rings. See Single Homing."

E

EC-1, EC-n

Electrical Carrier — The basic logical building block signal with a rate of 51.840 Mb/s for an EC-1 signal and a rate of n times 51.840 Mb/s for an EC-n signal. An EC-1 signal can be built in two ways: A DS1 can be mapped into a VT1.5 signal and 28 VT1.5 signals multiplexed into an EC-1 (VT1.5 based EC-1), or a DS3 can be mapped directly into an EC-1 (DS3 based EC-1).

ECI

Equipment Catalog Item — The bar code number on the faceplate of each circuit pack used by some inventory systems.

EEPROM

Electrically Erasable Programmable Read-Only Memory

EIA

Electronic Industries Association

EMC

Electromagnetic Compatibility

EMI

Electromagnetic Interference

EOOF

Excessive Out of Frame

EPROM

Erasable Programmable Read-Only Memory

EQ

Equipped (memory administrative state)

ES
Errored Seconds — A performance monitoring parameter. ES "type A" is a second with exactly one error; ES "type B" is a second with more than one and less than the number of errors in a severely errored second for the given signal. ES by itself means the sum of the type A and type B ESs.

ESD
Electrostatic Discharge

ESF
Extended Super Frame (format for DS1 signal)

EST
Environmental Stress Testing

F

FCC
Federal Communications Commission

FDDI
Fiber Distribution Data Interface

FE
Far-End. Any other network element in a maintenance subnetwork other than the one the user is at or working on. Also called remote.

FE-ACTY
Far End Activity — An LED on the user panel.

FEBE
Far End Block Error — An indication returned to near-end transmitting node that an errored block has been detected at the far end.

FE ID
Far End Identification — The 7-segment display on the faceplate of the SYSCTL circuit pack.

FEPROM
Flash EPROM — A new technology that combines the nonvolatility of EPROM with the in-circuit reprogrammability of EEPROM (electrically-erasable PROM).

FERF
Far-End-Receive Failure — An indication returned to a transmitting terminal that the receiving terminal has detected an incoming section failure.

FE SEL
Far End Select — An LED on the user panel.

FIT
Failures in10^{-9} hours of operation.

Free Running
An operating condition of a clock in which its local oscillator is not locked to an internal synchronization reference and is using no storage techniques to sustain its accuracy.

FT-2000
Lucent's SONET OC-48 lightwave system.

Function Unit
Refers to any one of a number of different circuit packs that can reside in the A, B, or C function unit slots on the DDM-2000 OC-3 Multiplexer, or in the A, B, C, or D function unit slots of the DDM-2000 OC-12 Multiplexer.

G

GNE
Gateway Network Element — A network element that has an active X.25 link. Can also be a DSNE.

GR
Telcordia Technologies General Requirement

Group
The eight slots that may be equipped.

GTP
General Telemetry Processor

GUI
Graphical User Interface

H

Hairpin Routing
A cross-connection between function units (*inter*-function unit). For example, function unit C to function units A or B. Also, a cross-connection within the same function unit (*intra*-function unit). Cross-connections go through main, but no bandwidth or time slots are taken from the backbone ring. Eliminates need for another shelf.

HECI
Humans Equipment Catalog Item

Holdover
An operating condition of a network element in which its local oscillator is not locked to any synchronization reference but is using storage techniques to maintain its accuracy with respect to the last known frequency comparison with a synchronization reference.

I

IC
Internal Clock. Used in synchronization messaging.

ID
Identifier. See shelf ID and site ID.

IEC
International Electrotechnology Commission

IMF
Infant Mortality Factor

INC
Incoming Status

INCM
A parallel telemetry point used to indicate incoming low-speed failures.

I/O
Input/Output

IP
Internet Protocol

IR
Intermediate Reach. A term used to describe distances of from 15 to 40 km between optical transmitter and receiver without regeneration. See long reach.

IS
In Service — One possible state of a DS1, DS3, or EC-1 port. Other possible states are "auto" (automatic) and "nmon" (not monitored).

ISCI
Intershelf Control Interface

ISI
Intershelf Interface

ISDN
Integrated Services Digital Network

IS-3
An intraoffice short reach proprietary interface provided by the 21D/21D-U and 22D-U optical line interface units.

ISO
International Standards Organization. See OSI.

IVHS
Intelligent Vehicle Highway System

J

Jitter

Timing jitter is defined as short-term variations of the significant instants of a digital signal from their ideal positions in time.

L

LAN

Local Area Network

LAPD

Link Access Procedure "D"

LBO

Line Build Out — An equalizer network between the DDM-2000 OC-3 and OC-12 Multiplexers and the DSX panel. It guarantees the proper signal level and shape at the DSX panel.

LCN

Local Communications Network

LEC

Local Exchange Carrier

LED

Light Emitting Diode — Used on a circuit pack faceplate to show failure (red) or service state. It is also used to show the alarm and status condition of the system.

Line Timing

The capability to directly derive clock timing from an incoming OC-N signal while providing the user the capability to provision whether switching to an alternate OC-N from a different source (as opposed to entering holdover) will occur if the OC-N currently used as the timing reference for that NE becomes unsuitable as a reference. For example, intermediate nodes in a linear network are line timed. See Loop Timing.

Local

See Near-End.

Locked Cross-Connection

This is a variation of the ring cross-connection that allows the user to lock the path selector to a specified rotation of the ring. Any signal received from the other rotation of the ring is ignored.

LOF

Loss of Frame — A failure to synchronize to an incoming signal.

Loop Timing
Loop timing is a special case of line timing. It applies to NEs that have only one OC-N interface. For example, terminating nodes in a linear network are loop timed. See Line Timing.

LOP
Loss of Pointer — A failure to extract good data from an STS-1 payload.

LOS
Loss of Signal — The complete absence of an incoming signal.

LR
Long Reach. A term used to describe distances of 40 km or more between optical transmitter and receiver without regeneration. See intermediate reach.

LS
Low Speed

M

Main
Slots on the DDM-2000 shelf in which the OLIU circuit packs are installed.

Midspan Meet
The capability to interface between two lightwave terminals of different vendors. This applies to high-speed optical interfaces.

MD
Mediation Device

MJ
Major Alarm

MM
Multimode

MML
huMan-Machine Language defined by ITU-TSS, formerly CCITT.

MN
Minor Alarm

MPEG
Moving Picture Experts Group

MSDT
Multi-Services Distant Terminal

MTBF
Mean Time Between Failures

MTBMA
Mean Time Between Maintenance Activities

Multiplexing
The process of combining several distinct digital signals into a single composite digital signal.

Mult
Multipling. The cascading of signals in a bay. In the MULT mode, the DS1 external reference can be cascaded to other shelves in a bay using Mult cables. Normally starting with the bottom shelf (Number 1) and working towards the top of the bay.

MUX
Multiplex

MXBIU
Multiplexer and Backplane Interface Unit

MXRVO Circuit Pack
The MXRVO circuit pack multiplexes seven VT-G signals from the DS1 circuit packs to an STS-1 signal for connection to the OLIU circuit packs.

N

NE
Near-End. The network element the user is at or working on. Also called local.

NE
Network Element — The basic building block of a telecommunications equipment within a telecommunication network that meets SONET standards. Typical internal attributes of a network element include: one or more high- and low-speed transmission ports, built-in intelligence, synchronization and timing capability, access interfaces for use by technicians and/or operation systems. In addition, a network element may also include a time slot interchanger.

NE-ACTY
Near End Activity — An LED on the user panel.

NEBS
Network Equipment-Building System

nm
Nanometer (10^{-9} meters)

NMA
Network Monitoring and Analysis — An operations system designed by Telcordia Technologies which is used to monitor network facilities.

NMON
Not Monitored — A provisioning state for equipment that is not monitored or alarmed.

Node
In SONET a node is a line terminating element.

Non-Revertive
A protection switching mode in which, after a protection switch occurs, the equipment remains in its current configuration after any failure conditions that caused a protection switch to occur clear or after any external switch commands are reset. (See Revertive.)

NRZ
Nonreturn to Zero

NSA
Not Service Affecting

NSAP
Network Services Access Point — An address that identifies a network element. Used for maintenance subnetwork communication using the OSI protocol.

NTF
No Trouble Found

O

OAM&P
Operations, Administration, Maintenance, and Provisioning

OC, OC-n
Optical Carrier — The optical signal that results from an optical conversion of an STS signal; that is, OC-1 from STS-1 and OC-n from STS-n.

OC-1
Optical Carrier Level 1 Signal (51.84 Mb/s)

OC-3
Optical Carrier Level 3 Signal (155 Mb/s)

OC-3c (STS-3c)
Optical Carrier Level 3 Concatenated Signal — Low-speed broadband signal equivalent to three STS-1s linked together with a single path overhead.

OC-12
Optical Carrier Level 12 Signal (622 Mb/s)

OHCTL
The overhead controller circuit pack provides user access to the SONET overhead channels.

OLIU
Optical Line Interface Unit

OOF
Out of Frame

OOL
Out of Lock

Operations Interface
Any interface that provides information on the system performance or control. These include the equipment LEDs, user panel, CIT, office alarms, and all telemetry interfaces.

OPS/INE
Operations System/Intelligent Network Element

OS
Operations System — A central computer-based system used to provide operations, administration, and maintenance functions.

OS-GNE
Operations System - Gateway Network Element

OSI
Open Systems Interconnection — Referring to the OSI reference model, a logical structure for network operations standardized by the International Standards Organization (ISO).

OSGNE
Operations System Gateway Network Element — An OSGNE serves as a single interface to the OS for NEs in the same subnetwork using X.25 interfaces.

OSMINE
Operations Systems Modifications for the Integration of Network Elements.

OSP
Outside Plant

P

Pass Through
Paths that are cross-connected directly across an intermediate node in a ring network.

P-bit
Performance Bit

PC
Personal Computer

PCU
Power Conversion Unit

PID
Program Identification

PINFET
Positive Intrinsic Negative Field Effect Transistor

PJC
Pointer Justification Count

Plesiochronous Network

A network that contains multiple maintenance subnetworks, each internally synchronous and all operating at the same nominal frequency, but whose timing may be slightly different at any particular instant. For example in SONET networks, each timing traceable to their own Stratum 1 clock are considered plesiochronous with respect to each other.

PLL

Phased-Locked Loop

PM

Performance Monitoring — Measures the quality of service and identifies degrading or marginally operating systems (before an alarm would be generated).

PMN

Power Minor Alarm

POH

Path Overhead

POP

Points of Presence

Port

The physical, electrical, or optical interface on a system. For example, DS1, DS3, EC-1, OC-3, and OC-12. See Channel.

Port State Provisioning

A feature that allows a user to suppress alarm reporting and performance monitoring during provisioning by supporting multiple states (automatic, in-service and not monitored) for low speed ports. See Channel State Provisioning.

POTS

Plain Old Telephone Service

Proactive Maintenance

Refers to the process of detecting degrading conditions not severe enough to initiate protection switching or alarming, but indicative of an impending signal fail or signal degrade defect (for example, performance monitoring).

Protection Line

As defined by the SONET standard, the protection line is the pair of fibers (one transmit and one receive) that carry the SONET APS channel (K1 and K2 bytes in the SONET line overhead). On a DDM-2000 OC-3 system, a *protection* line is a pair of fibers that terminate on an OLIU circuit pack in the `main-2`, `fn-a-2`, `fn-b-2`, or `fn-c-2` slot. (See "Service Line.")

PRM

Performance Report Message

PROTN

Protection

Product Family 2000
Lucent's line of SONET standard network products providing total network solutions.

PRS
Primary Reference Source

PSU
Power Supply Unit

PVC
Permanent Virtual Circuit

PWR
Power

R

RAM
Random Access Memory

Reactive Maintenance
Refers to detecting defects/failures and clearing them.

Remote
See Far-End (FE)

Revertive
A protection switching mode in which, after a protection switch occurs, the equipment returns to the nominal configuration (that is, the service equipment is active, and the protection equipment is standby) after any failure conditions that caused a protection switch to occur clear or after any external switch commands are reset. (See "Non-Revertive.")

Ring
A configuration of nodes comprised of network elements connected in a circular fashion. Under normal conditions, each node is interconnected with its neighbor and includes capacity for transmission in either direction between adjacent nodes. Path switched rings use a head-end bridge and tail-end switch. Line switched rings actively reroute traffic over a protection line. Ring (0x1) Low Speed Interface

Formerly referred to as dual 0x1 or single 0x1. In ring applications, the DDM-2000 OC-3 and OC-12 Multiplexers use a 0x1 interface meaning both fibers carry service as opposed to a linear (1+1) low speed interface where one fiber is used for service and the other for protection. See 1+1.

RPP
Reliability Prediction Procedure — Described in Telcordia Technologies TR-NWT-00032.

RT
Remote Terminal — An unstaffed equipment enclosure that may have a controlled or uncontrolled environment.

RTAC
Lucent Regional Technical Assistance Center (1-800-225-RTAC)

RZ
Return to Zero

S

SA
Service Affecting

SCADA
Supervisory Control and Data Acquisition

SD
Signal Degrade

SDH
Synchronous Digital Hierarchy

Self-Healing
Ring architecture in which two or more fibers are used to provide route diversity. Node failures only affect traffic dropped at the failed node.

SEFS
Severely Errored Frame Seconds

SEO
Single-Ended Operations — The maintenance capability that provides remote access to all DDM-2000 systems from a single location over the DCC.

Service Line
On a DDM-2000 system, a service (or "working") line is a pair of fibers (one transmit and one receive) that terminate on an OLIU circuit pack in the `main-1`, or `fn-a-1`, or `fn-b-1`, or `fn-c-1` slot. As defined by the SONET standard, the SONET APS channel is not defined on a service (or "working") line. (See "Protection Line.")

SES
Severely Errored Seconds — This performance monitoring parameter is a second in which a signal failure occurs, or more than a preset amount of coding violations (dependent on the type of signal) occurs.

SF
Super Frame (format for DS1 signal)

Shelf ID
A switch settable parameter with values of from 1 to 8. Used to log into a selected shelf in a bay using the CIT.

SID
System Identification

Single 0x1 Cross-Connection
In a dual-homed application, the DDM-2000 OC-3/OC-12 Multiplexer uses a single 0x1 cross-connection to map the VT1.5 channels between the DDM-2000 FiberReach OC-1 and the DDM-2000 OC-3/OC-12 rings. This single 0x1 architecture maps low speed to high speed on a specified ring rotation. The high speed to low speed drop is made on the same specified ring with no path switching. Protection is provided at the VT1.5 end points. See Dual 0x1.

Single Homing
In DDM-2000 FiberReach, a network topology in which a single OC-3 shelf serves as a DDM-2000 FiberReach Multiplexer host supporting up to six OC-1 rings. A *SLC*-2000 Access System serving as a host can support up to two OC-1 rings. See Dual Homing.

Site ID
A switch settable parameter with values of from 1 to 8. Displayed on SYSCTL circuit pack to indicate to which site the user panel alarms and LEDs apply.

SLIM
Subscriber Loop Interface Module

SM
Single Mode

SONET
Synchronous Optical NETwork

SPE
Synchronous Payload Envelope

SQU
Sync Quality Unknown. Used in synchronization messaging.

SRD
Software Release Description

Standby
Standby identifies a 1+1 protected OC-N line which is not currently selected by the receiver at either end as the payload carrying signal, or a 1x1 or 1xn protected circuit pack that is not currently carrying service. (See Active.)

Star Topology
For DDM-2000 FiberReach, this refers to a configuration of multiple point-to-point OC-1 extensions from a single DDM-2000 OC-3/OC-12 Multiplexer.

Status
The indication of a short-term change in the system.

STS, STS-n
Synchronous Transport Signal — The basic logical building block signal with a rate of 51.840 Mb/s for an STS-1 signal and a rate of n times 51.840 Mb/s for an STS-n signal.

STS-1 SPE
STS-1 Synchronous Payload Envelope — A 125-microsecond frame structure composed of STS path overhead and the STS-1 payload.

STS-3c
Synchronous Transport Level 3 Concatenated Signal. See OC-3c.

Subnetwork
Group of SONET network elements that share a SONET data communications channel.

Synchronization Messaging
SONET synchronization messaging is used to communicate the quality of network timing, internal timing status, and timing states throughout a subnetwork.

SYSCTL
The system controller circuit pack that provides overall administrative control of the terminal.

T

T1EXT
T1 Carrier Extension Circuit Pack

T1X1 and T1M1
The ANSI committees responsible for telecommunications standards.

TA
Telcordia Technologies Technical Advisory

TABS
Telemetry Asynchronous Byte Serial (Protocol)

TARP
Target ID Address Resolution Protocol

TBOS
Telemetry Byte-Oriented Serial (Protocol) — Defines one physical interface for direct connection between the telemetry remote and the monitored equipment. An RS-422 port is used to provide the operations system with sufficient alarm and status information to localize a problem to a given DDM-2000 and to determine the severity of the problem.

TCA
Threshold-Crossing Alert — A condition set when a performance-monitoring counter exceeds a user-selected threshold. A TCA does not generate an alarm but is available on demand through the CIT and is shown by TBOS and causes a message to be sent to NMA via the X.25/TL1 interface.

TCVCXO
Temperature-Compensated Voltage-Controlled Crystal Oscillator — A highly stable and accurate clock source used in the DDM-2000 TGS circuit pack.

TGS
The timing generator circuit pack generates clock signals for distribution to the transmit circuits. It operates in the free-running, loop-timing, phase-lock, and holdover modes.

TID
Target Identifier — The Telcordia Technologies name for the system name.

TL1
Transaction Language 1 — A Telcordia Technologies machine-to-machine communications language that is a subset of ITU-TSS, formerly CCITT's, human-machine language.

TLB
Timing Looped Back. Used in synchronization messaging.

TOP
Task Oriented Practice

TR
Telcordia Technologies Technical Requirement

TSA
Time Slot Assignment

TSI
Time Slot Interchange

TSO
Technical Support Organization — Supports RTAC and the customers.

U

UAS
Unavailable Seconds. In performance monitoring, the count of seconds in which a signal is declared failed or, in which, 10 consecutively severely errored seconds (SES) occurred, until the time when 10 consecutive non-SES occur.

Unidirectional
A protection switching mode in which the system at each end of an optical span monitors both service and protection lines and independently chooses the best signal (unless overridden by an equipment failure or by an external request, such as a forced switch or lockout). In a system that uses unidirectional line switching, both the *service* and *protection* lines may be *active* simultaneously, with one line carrying traffic in one direction and the other line carrying traffic in the other direction. For a 1+1 protection scheme the K1 and K2 bytes in the SONET line overhead are used to convey to the far end which line the near end receiver has chosen, so that an "active" indication may be made at the far end.

UOC
Universal Optical Connector — Receptacles on the faceplate of some OLIUs that accept *ST*®, SC, or FC connectors.

UPD/INIT
A pushbutton on the user panel.

V

VF
Voice Frequency

VLSI
Very Large Scale Integration — Refers to very complex state of the art integrated circuits.

VM
Violation Monitor — A mode of the DS3 circuit pack in which it will monitor but not remove P-bit parity violations on the DS3 signal received from the fiber.

VMR
Violation, Monitor, and Removal — A mode of the DS3 circuit pack in which it will monitor and remove P-bit parity violations on the DS3 signal received from the fiber.

VONU
Virtual Optical Network Unit

VT
Virtual Tributary — A structure designed for transport and switching of a sub-DS3 payload.

VT1.5
A 1.728 Mb/s virtual tributary

VT-G
Virtual Tributary Group — A 9-row by 12-column SONET structure (108 bytes) that carries one or more VTs of the same size. Seven VT groups (756 bytes) are byte-interleaved within the VT-organized STS-1 synchronous payload envelope.

W

WAN
Wide Area Network

Z

Zero Code Suppression
A technique used to reduce the number of consecutive zeros in a line-codes signal (B3ZS for DS3 signals and B8ZS for DS1 signals).

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